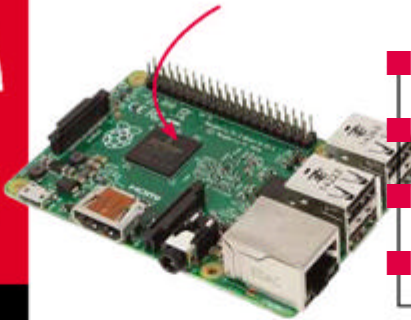


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**The psychological tricks
that make us click**

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Broadband from space

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Stop thief!

How to protect
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being stolen p38



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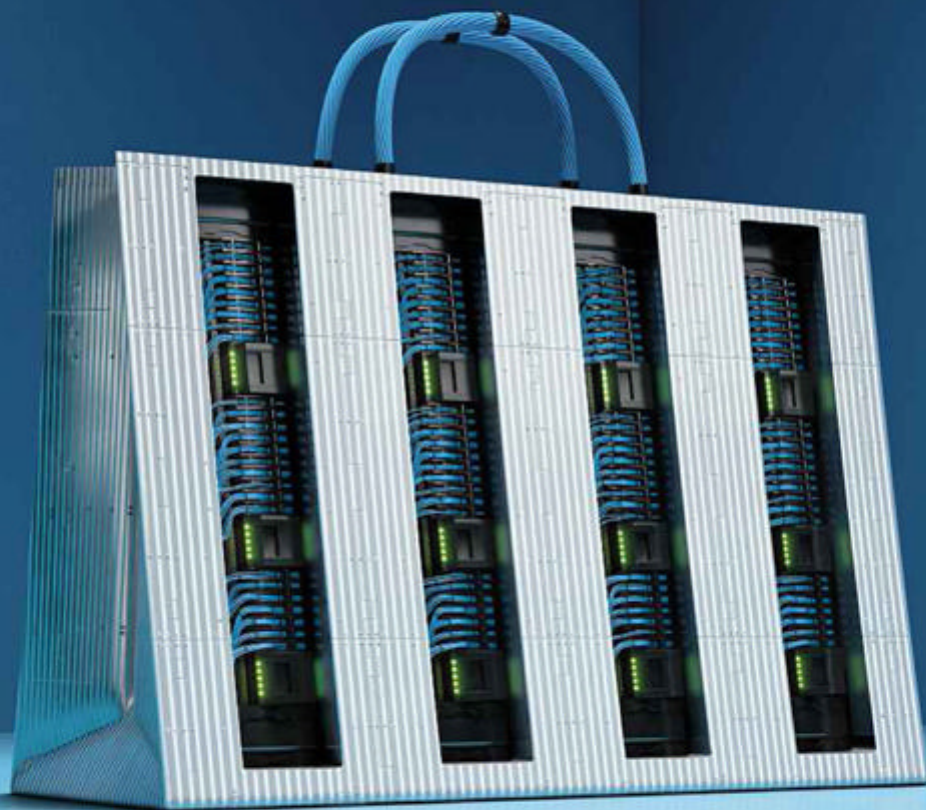
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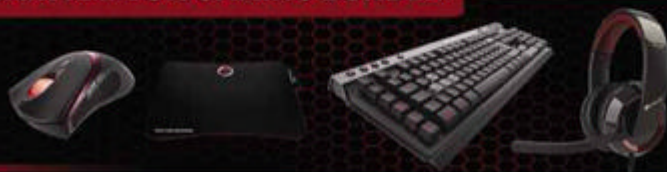


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Editor's letter

BEFORE I'D EVEN completed my sentence, explaining I was going into town and would she like to join me, my seven-year-old daughter fixed me with a stare: "I'll be down by the front door in my coat in less than a minute." In short, she was keen.

This was partly because it was an unfamiliar town – we were visiting her grandparents in Congleton, Cheshire – but also because she had a purse weighed down by four pound coins and was on a mission to spend. Baroness Thatcher would have been proud.

By the time we'd completed the short walk from house to town centre, my daughter's eyes were acclimatised to her hunt for toys. She'd taken it in her stride that the toy shop we'd previously visited here was closed – after triple-checking that this wasn't one of her father's evil ruses to stop her going into toy stores – and was now on the hunt for other shops selling what she so badly needed.

"There!"

I looked doubtfully at the Costcutter she was pointing to, unable to see past the barrage of plastic boxes, mops and motley household items. "Are you sure?"

"Come on Daddy." I was manhandled into the shop, where indeed there were some toys hiding away just inside the doorway.

Now, we all know the hackneyed truism about death and taxes: the real truth in life is that we love a bargain and hate to feel cheated. So I tried to ignore the fact that there, sitting bold as brass on a shelf, was the ceramic cat money box that had caught my daughter's eye four weeks earlier in a Chesham toy shop. I'd paid £2.50 for it; here, it cost £1. I consoled myself that even if I'd known, my daughter wouldn't have waited a month for the sake of £1.50.

Ten minutes later we emerged, my daughter clutching her new clockwork mouse. This time I felt confident we hadn't been cheated: 75p for a clockwork mouse? It was like being back in the 1970s. Unfortunately, the same could be said for the merchandising. There's much that's great about Congleton, but the subtlety of shop fronts isn't it: pile 'em high, make 'em shiny and price 'em low.

It's just one of the tactics employed by bricks-and-mortar shops to get customers through doors; online retailers use more "sophisticated" means. Even to a seasoned online shopper, the tricks revealed in our Buy Me feature (see p44) are a little shocking. Skilful phrasing, scare tactics so we believe time is against us: there really isn't a level too low for online retailers to stoop to.

But fear not. We can use their tricks to our advantage. On our return from Congleton, my middle son – having been suckered into downloading a trial of a Sims-like game on his Nintendo 3DS – played his own tricks to make me order the full version. This involved a mix of pleading, pouting and wide-eyed "you wouldn't deny a child as cute as me, would you?" techniques, and, naturally, it worked.

I employed one of the hints advocated in the feature: never search using the online retailer's search box because by that time they know they've got you hooked and won't necessarily give you the lowest price. Within seconds I'd found the best price and was pressing Amazon's orange Buy button. And if you're wondering why it's orange – well, that's another trick we reveal in the feature.

Tim Danton
Editor-in-chief

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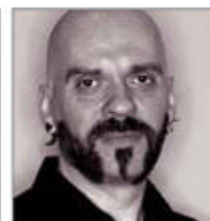
James Morris Former *PC Pro* editor James is now a professional videographer, so he was our obvious choice to torture-test workstation PCs. See p78 for his verdict.



Roger Carey How do you inform customers how much data they've used if the measuring tools disagree? Roger from Village Networks shares his findings on p116.



Joel Snape As acting editor of *Men's Fitness*, Joel knows about staying fit. Turn to p58 for his tips on doing so while still sitting at your desk eight hours a day.



Davey Winder A warning: the wireless keyboard you're using opens up a new avenue of attack. Davey explains how to stay safe, and pays homage to David Gold, on p118.

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"Before I started working with computers, I had hair and perfect vision. I was also considerably taller."

"I once broke my toe walking barefoot into a UPS. The perils of a home office."

"Only the occasional bout of Nintendonitis when trying to get through a tough level of a game."

"It's definitely affected my posture over the past few years."



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Do schools really need to spend more on tech? **p14**

PC Probe

Why Cameron can't – and won't – ban encryption **p16**

Working to avoid a “forgotten century” of data

Internet pioneer Vint Cerf has warned that we risk losing a generation of data through “bit rot”.

Nicole Kobie speaks to archiving experts to find out how we can protect our historical information

TODAY WE CAN access blogs, tweets, photos and other files from anywhere, thanks to the cloud – but will we still be able to access them in the future?

Vint Cerf, Google vice president and co-creator of the TCP/IP protocol, warned in *The Guardian* that as the programs needed to view certain file types fall out of use, data will become inaccessible to future generations. “When you think about the quantity of documentation from our daily lives that’s captured in digital form – such as our interactions via email, people’s tweets, and all of the world wide web – it’s clear that we stand to lose an awful lot of our history,” he told the newspaper.

“If we want to preserve them, we need to make sure that the digital objects we create today can still be rendered far into the future,” he added (see pcpro.link/247vintcerf).

■ Fighting back

Experts say Cerf is right to worry – but work is already underway. “It’s a challenge we’re aware of,” said David Clipsham, a digital-archiving specialist at the National Archives. “Nobody can predict the future, but we feel we’re ahead of the curve.”

Alongside the work being done in storing government documents at the National Archives, the British Library is also saving billions of web

pages (see *Preserving the UK’s digital memory, below*), and the US Library of Congress is even collecting tweets.

Nevertheless, Robb Moore, CEO of disaster-protected storage manufacturer ioSafe, shared Cerf’s concerns. “Preserving and archiving digital data for long-term storage and retrieval is a problem,” he told *PC Pro*. “Not only does the actual medium grow old, but the compatible devices that interface with the medium also get old,” he said. “I have a Zip drive at home containing 10-year-old data. I’m sure it would be far from trivial to get it working on my new MacBook Air, with no drivers and no parallel port.”

Preserving the UK’s digital memory

The British Library’s Web Archiving project stores a snapshot of the web for posterity. We spoke to Helen Hockx-Yu, head of web archiving, and Maureen Pennock, head of digital preservation, to find out more.

What’s the goal of this project?

A key purpose of the British Library is to build, curate and preserve the UK’s written, published and digital memory. In 2013, new legislation enabled us to archive digital content on a mass scale.

Every day we ingest masses of digital information. This includes the entire .uk web domain (more than four billion pages so far), ebooks, ejournals, electoral registers, patents, audio and audio-visual content, images scanned from books and manuscripts, e-theses, and even a small number of personal digital archives – such as that of poet Wendy Cope, acquired in 2010, which included 40,000 emails.

How are you ensuring it can be read in the future?

We run an active R&D programme, built on almost two decades of international research, which aims to develop knowledge and solutions to support long-term preservation of our digital collections. We’re also developing preservation services specifically for the web archive. We have built a prototype service designed to help us find the content that users can’t and, where possible, to provide alternative ways of accessing that content.

How do you store it?

The library’s digital content is stored in our Digital Library System, and there are no limitations on the file formats that can be stored here. In order to identify the risks related to older file formats, we carry out format characterisation during our indexing and ingest processes. This enables



format identification and validation, metadata extraction, and allows us to monitor the risks related to older file formats and take action if required.

For some collections, we need to provide the software that’s required to access those resources. In the future this may include the provision of

emulated or virtualised environments, as well as format conversion.

Fortunately, our research indicates that the common formats are unlikely to become obsolete in the next couple of decades – although it’s likely that new versions of some formats will be released in that time.

DVDs may be facing a similar fate: their 4.7GB capacity made them a popular backup medium a decade ago, but nowadays optical drives on laptops are few and far between. The advent of cloud storage may seem to alleviate such issues – Dropbox users, for example, don't even know what sort of storage medium their data is kept on. But that certainly doesn't mean online storage is risk-free.

"Online content is most at risk in my opinion," warned Moore, "as the firm you're dealing with probably cares little about archiving your data. They might have a glitch, go bankrupt or change their policy, making retrieving that data impossible. It's up to you to archive whatever you consider precious or important."

■ Obsolete formats

It isn't only storage hardware that becomes obsolete: even if you can access old data, you may not be able to open it without the right software. "Generally, choosing the most generic formats is the best way to keep data usable far into the future," said Moore. "For pictures, it's JPEGs. PDFs and text files should also work well for the long term – I can't imagine a digital world where reading a JPEG or PDF will become impossible. If there does come a time when an old format is going away, you'll need to be diligent enough to perform a mass conversion to a more generic format wherever practical."

Back at the National Archives, Clipsham told us that, while archiving official documents raises challenges, the government's file formats were "pretty homogeneous": most arrive as standard documents and images, with 99% of files in fewer than 20 file formats. Many of these have



ABOVE Vint Cerf sees a need for greater digital archiving

already had a long life: GIF, for example, came out in 1987, but "it's as popular as ever", Clipsham said. "The wider-known formats tend to not go away. That said, we do maintain an internal software library to be able to understand formats when we need to, and we sometimes use emulation."

For those dealing with only their own data, Moore recommended "saving it forward" to keep data safe. "Every few years I migrate my entire data wad to my next new device," he said. "I work to keep everything, old and current, on a single master volume, backed up to multiple targets. I export my entire email database from Outlook as a snapshot archive."

One measure suggested by Cerf was to print out photos. "Vint is correct that digital content will be lost if no-one preserves it," according

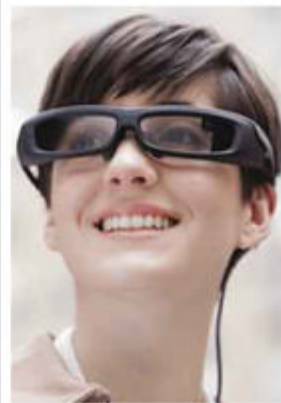
to Helen Hockx-Yu, head of web archiving at the British Library. "This isn't dissimilar from paper records, which will degrade if not managed properly, such as in a temperature- and humidity-controlled store. The time frame with digital is shorter, however, and the dependencies for preservation are more complex." ●

“ Preserving and archiving digital data for long-term storage and retrieval is a problem ”

Five stories not to miss

1 Fishy software on Lenovo laptops

Kaspersky revealed that a hacking group has been using advanced malware that can't be removed from hard drives – and suggested the threat might have ties to the NSA. Lenovo subsequently admitted that the Superfish software preinstalled on some of its laptops left users open to online attacks.



2 Sony unveils its own smart glasses

Forget Google Glass: Sony has launched its own smart glasses, just weeks after Google discontinued the first version of its device. Sony's SmartEyeglass will show notifications directly in front of your eyes, and connects to a power and control unit via a cable. The headset arrives in the UK in March for £520.



3 Free Wi-Fi on British trains

David Cameron promised that rail commuters in England and Wales will get free Wi-Fi on trains from 2017. The government will shell out £50 million to encourage operators that don't yet have Wi-Fi to offer the service, with funding going to the best proposals.

4 Ubuntu phone goes on sale

The first smartphone based on the open-source Ubuntu OS is now available. The BQ Aquaris E4.5 costs around £130 and features a 540 x 960, 4.5in screen and a 1.3GHz ARM Cortex-A7 chip.



5 Firefox's Flash without a plugin

The experimental version of Mozilla's Firefox browser can now play some Flash videos without the need for a plugin, reducing users' exposure to possible hacker exploits. Mozilla's Shumway project uses JavaScript to play Flash content on sites that have been whitelisted, although so far that's limited to Amazon.com.



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Sneak peek at Windows 10 for smartphones

Microsoft is giving Lumia owners an early taste of Windows 10 on their phones

Despite Microsoft's promise of a single operating system for all devices, the first Windows 10 preview builds have been for desktops and laptops only. However, the company has moved one step closer to its vision of a unified OS by releasing a version of Windows 10 that will work on a limited number of Lumia handsets.

HOW TO GET IT Want to try Windows 10 on your handset? First, you'll need to join the Windows Insider Programme (insider.windows.com) and register your device.

This will install the Windows Insider app on your phone, after which you can follow the prompts to install the new OS. If it all goes terribly wrong, you can always roll back your device to Windows Phone 8.1.

Microsoft said most Lumia handsets will be upgradeable to Windows 10, but only a small number currently work with

the Technical Preview, namely the Lumia 630, 635, 636, 638, 730 and 830. Treat this list with caution, however: we tried to install Windows 10 on the 830 without success. Higher-end handsets, such as the 930 and 1520, will eventually be supported.

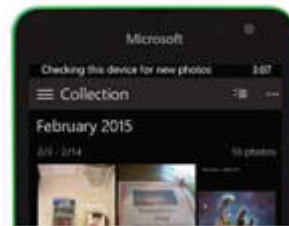
Programme manager Gabriel Aul warned that you may not want to use the new operating system on your main handset. "You will encounter bugs," he admitted, but added that this is to be expected given this is the "earliest publicly available preview" for Windows on phones.

"You will likely feel like this first preview build for phones seems 'less complete' or 'earlier' than the PC. That's true – it is."

Read our in-depth review of Windows 10 Technical Preview for phones on p68.



Speech integration UK users won't yet see Cortana in Windows 10, but you can still talk to your phone: Microsoft claims speech-to-text can now be used for most data fields.



Updated apps Some apps have been updated, including the calculator and Photos, and Microsoft is working on a version of Outlook that works across all devices. Skype is built in, letting you use its messaging tool in SMS conversations.



Improved settings This has seen a big upgrade, with many more "quick settings" for, say, adjusting brightness. It's also simpler to respond to notifications, such as texts, directly.

Rural areas "neglected" despite Virgin's £3bn for broadband

VIRGIN MEDIA'S £3 billion investment in broadband hasn't pleased rural campaigners, who fear tough-to-reach neighbourhoods will again be left out of fibre rollouts.

Virgin said its "Project Lightning" would cover four million more homes by 2020, offering speeds of 152Mbps/sec. The investment follows BT's announcement that its G.fast technology could offer 500Mbps/sec to much of Britain by 2020 (see p127).

While that may sound like good news, Virgin has said that the upgrade will focus on "areas closest to its existing network" – prompting campaigners from the Country Land and Business Association to warn that the plan would "exacerbate the rural-urban digital divide".

Thinkbroadband analyst Andrew Ferguson said Virgin's priorities were no surprise. "Virgin Media plans to deploy a fibre/co-ax hybrid network right up to the door, rather than the cabinets BT opted for. This incurs higher costs – hence the creation of 6,000 jobs," he told PC Pro.



ABOVE The rural-urban digital divide is no closer to being resolved

"If this technique were used in the rural areas of the UK – and by 'rural' we're talking about villages of 2,000 homes or fewer – then the cost would have been much higher, and the investment of £3 billion might only have reached one to two million premises rather than the planned four million," he added.

Those who will benefit include people who live in urban areas where

"one side of a road has access to cable broadband but another does not". Indeed, in announcing the investment, Virgin specifically mentioned parts of London, notably the East London neighbourhood that's home to Tech City.

Such areas aside, Virgin's investment may serve more to increase competition with BT than extend coverage areas; Ferguson predicts that the new Virgin fibre

areas will "largely overlap" BT's own fibre infrastructure. "As things stand, there are around 700,000 premises within 20 metres of the existing Virgin Media network, from our own calculations," he revealed. "It's these locations that are most likely to see the initial rollout, as well as those relatively new estates that were built in towns after the original cable rollouts were completed."

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Bett Special

What technology do schools really need?



Not everyone is convinced that schools need more technology. **Nicole Kobie** asks experts at the Bett educational tech show where investment should be happening

ARE SCHOOLS SPENDING too much money on tech, as opposed to investing in teachers? It's hard to imagine anyone being distracted by such thoughts as they walked the halls of Bett, the massive educational technology show held in London each year, with everything on show from smart whiteboards to in-class robots.

But the question has been raised. Russell Hobby, the leader of the National Association of Head Teachers, wrote in a blog post before January's show that the £716 million predicted to be spent on IT this year could fund 20,000 new teachers. "Can this spend possibly be justified at a time of austerity?" he asked.

The tech firms believe this is a false argument, pointing out that British students need up-to-date technology to develop modern workplace skills.

“The number of PCs in schools is at a record high, but teachers need training to keep ahead of the tech curve”

Eileen Lento, government and education strategist at Intel, told *PC Pro* that while basics such as reading, writing and arithmetic remain important, they're "not the only thing you need to do". Liz Sproat, EMEA head of education for Google, argued that skills such as problem-solving, teamworking and communication are valued "as highly if not more highly than literacy". Speaking of such business skills and technology, she added: "I'm not sure we can afford to wait until our young people reach their twenties to develop these skills."

And, to teach, schools need the same quality of infrastructure found in businesses.



■ Back of the class

Despite the importance of such skills – and the hundreds of millions spent on classroom IT – many schools can't deliver that infrastructure. Nicky Morgan, secretary of state for education, said at her Bett keynote that while many schools are making use of innovative technologies, "the fruits of that success aren't yet shared by every school in the country". She

ABOVE & BELOW

Visitors to Bett agree that technology supported by teacher training will be key to improving tech education in the UK

pointed to statistics from the British Educational Suppliers Association revealing that 65% of primary schools and 54% of secondary schools have problematic Wi-Fi.

The inability to get such IT basics right makes it more difficult for schools to create innovative environments, in which students have the technology at their fingertips to access key information.

To illustrate this, Sproat showed us an image of an ideal classroom, with happy students scattered about with books, tablets and laptops. "Behind every classroom that looks like this, there's a network manager in the background up to their eyeballs in USB cables trying desperately to manage all the hardware, software and content to make it available in just the right format to every student and teacher," she said, adding that this reliance on old-fashioned technology is why so many schools are stuck with traditional classrooms.



Image (bottom): Dave Stevenson

Teacher training

So if it's clear that investment is needed in infrastructure, where else should schools be spending? The number of computers in British schools is already at a record high, and devices such as the Raspberry Pi (see p62) make it easier to bring computing into schools for less money. However, teachers need more training to keep ahead of the tech curve.

"This is a real challenge," Morgan told Bett attendees. "The pace of change today is such that it's genuinely difficult for generations like mine to keep up. Even the more switched-on among us might struggle to adapt to a world that changes so quickly; a world in which even the language of digital natives, digital settlers and digital immigrants seems somewhat redundant. It's hardly surprising, therefore, that teachers and school leaders sometimes struggle to keep up."



ABOVE Education secretary Nicky Morgan pointed out that some schools are still struggling with basic technology such as Wi-Fi

The government has already pledged £3.6 million to help fund training for the new computing curriculum, and Morgan revealed at Bett that Google, IBM, Microsoft and O2 would be working with universities to help train more computing teachers, and would visit primary schools to boost their tech skills. "It's important that our

teachers and school leaders should be given every opportunity to stay on top," she said.

However, since that spending is but a tiny slice of the £716 million predicted to be lavished on school technology this year, it's easy to see where headteacher Hobby is coming from. "As education leaders, we must guard against fads and panaceas," he added in his post. "Technology has no value in itself, only in relation to the problems it solves."

One solution could be to include teachers in the buying decisions. Vicki Phillips, director of education at the Bill & Melinda Gates Foundation, told Bett attendees that "right now, teachers aren't buyers", claiming they're given little input into what's bought for their own classrooms. "The need for educational tech companies to listen to teachers is a bigger issue than it might seem," she said, adding that technology "must be seen as a tool, not a goal."

Copying Chromebooks

Sales of Google's Chromebooks are gathering pace in schools, it appears, with the company claiming that a fifth of US school districts are using them in classrooms.

The cheap-and-cheerful laptops run the Chrome OS operating system and have little built-in storage, relying instead on the web to supply apps and on cloud services for storage. Since Samsung released the first device in 2011, Chromebooks have failed to find favour with businesses and consumers, making up only 1% of all PC sales, according to ABI Research.

However, seeing their success in schools has spurred others to have a go. Microsoft and its partner manufacturers are looking to develop their own take on the idea, while still offering students a fully fledged version of Windows, the OS used most in schools. HP unveiled its Stream 11 Pro for Education at Bett, a £179 laptop designed to compete with Chromebooks: with limited storage, the 11.6in lightweight laptop is similar in many ways to the HP Chromebook 11, but runs Windows 8.1.

"This exponential growth in Chromebooks proves there's a need – schools want a low-cost device that's lightweight and easy to manage," HP's vice president of worldwide education Gus Schmedlen told *PC Pro* at Bett. "When you see more people enter a market, the one conclusion you can draw is that the market is working."

He noted that the Chromebook model may appeal to many schools, but some may be unwilling or unable to shift away from Windows because of previous investments. "It's nice to have alternatives, especially for those schools that have already invested in Microsoft infrastructure and Office 365."

Google isn't worried about the competition, saying that moving schools to modern IT systems



isn't currently easy or cheap. "If the whole market moves with us in making it easier for students to buy devices, then frankly we're pretty cool with that," Liz Sproat, Google's head of education for EMEA, told *PC Pro* at the show. "We're happy to see providers trying to reduce costs."

Take your tablets

Chromebooks and devices such as the HP Stream are most popular in secondary schools, HP's Schmedlen said, but "we have seen a giant shift to tablets in primary schools".

While Google led with Chromebooks, it's had to play catch-up with tablets: the tech giant

used Bett to announce its first two pieces of education-dedicated tablet hardware. These versions of the Nexus 7 and Samsung Galaxy Tab 4 come with school-friendly management tools, including an NFC-based system that enables teachers to set up multiple tablets by tapping two units together.

But are Chromebooks and tablets sufficient for coding purposes, a requirement of the UK curriculum that will see students learning to program even at primary school level? "Absolutely," Schmedlen said. "Coding can now be done online: students will not only be able to learn the basics of coding, but they'll also be able to complete entire projects."



PC Probe

Why Cameron can't – and won't – ban encryption

The prime minister wants access to our digital communications, but that doesn't mean he'll get it. **Stewart Mitchell** reveals why backdoors and bans aren't the answer



In the wake of the terrorist attacks in Paris in January, prime minister David Cameron promised a clampdown on online communications – with his comments taken by many as a threat to ban encryption.

“Are we going to allow a means of communication which it simply isn't possible to read?” he asked. “My answer to that question is: ‘no, we must not’.”

Since banking, e-commerce and messaging systems all rely on cryptography, the prime minister's speech was met with ridicule, with tech-savvy Liberal Democrat MP Julian Huppert saying “this ludicrous proposal is technologically illiterate”.

When *PC Pro* contacted the Cabinet Office for clarification, a spokesperson suggested Cameron's quote had been taken out of context – but confirmed that the government wants more access to communications.

“This government supports encryption,” a spokesperson said. “Without the development of strong encryption allowing the secure transfer of banking details, there would be no online commerce. This is not about banning internet companies in the UK, or about reading everyone's emails. It is about finding a way to work with communications service providers as technology develops to ensure that, with clear oversight

and a legal framework, the police and intelligence agencies can access the content of communications.”

What neither the Cabinet Office nor Cameron explained is how the government proposes to do this. There are two obvious methods: legislating for backdoors, or requiring communications companies to surrender keys with a court order.

■ Backdoor worries

Backdoors, where tech firms leave a hole in encryption to give authorities an access point, appeal to many within the security services since they provide fast, unfettered access to content. Unfortunately, it's impossible to stop their use by criminals.

Campbell Murray, technical director of security firm Encryption, said that in theory it could be possible for the government to press commercial encryption providers to include backdoors. However, he warned:

“How long will it take analysts and hackers to find that backdoor? Not long, in which case you have no encryption.”

Those backdoors could also be used by other governments. “Authorities elsewhere, such as in China, will be able to insist to big providers that they be entitled to the kind of eavesdropping in their jurisdictions that other states get in theirs,” predicted Jonathan Zittrain, professor of internet law at the Harvard Law School. “It would want the same backdoor the UK wants.”

■ Establishment encryption

UK authorities already have the authority to demand encryption keys, under the Regulation of Investigatory Powers Act 2000, but it's limited to cases where they

believe a message contains relevant communications from someone already suspected of wrongdoing.

“If a mail account is suspected of being used to organise drug or people trafficking, for example, then if it's under investigation, the UK lawmakers can go to Google or whoever and say, ‘We want access

“How long will it take analysts and hackers to find a backdoor? Not long, in which case you have no encryption”

to that account', regardless of whether or not the data is encrypted," said Murray.

The government may push for easier access to such keys – but it wouldn't be the first time businesses rebuffed such a move. "The Home Office wanted a general power to compel the production of decryption keys, and the banks said: 'No way – there's no way we want some bent copper going to a 24-year-old shift supervisor in our data centre and getting the signing keys for our funds-transfer system'," said Ross Anderson, professor of security engineering at the University of Cambridge. "The compromise was that keys could only be demanded by a chief constable and had to be presented at director level in an organisation."

■ Encrypt yourself

Demanding encryption keys also works only if the company is performing the encryption itself. "If it's a large corporate, it can get the key – the problem is someone sending encrypted emails from their PC, because the person that holds keys is the person that is likely to be the suspect," said Chris Pounder, an information-security lawyer and director of Amberhawk, which provides training in information law. "What they might like to ban is software where the encryption key is in the control of the end user."

Banning such tools might appeal to authorities, but it's impossible to purge them from the internet – and a law won't stop the worst criminals. "If I'm going to blow somebody up, I'm not going to worry about using banned software," said Pounder.

The worry that end-user encryption provides a safe haven for criminals or terrorists is real, but it can also be used to find them. Traffic encrypted using less common methods is sometimes easier to spot than messages mixed

RIGHT David Cameron wants the police and intelligence agencies to be able to access the content of communications far more easily



in with millions of similar messages. "If you want to actually hide traffic, you have to hide it in lots and lots of similar traffic," said Anderson. "I've spoken to someone in Texas whose job it is to spread the gospel in countries such as Pakistan, where if you convert you get executed. You couldn't realistically ask your converts to use Pretty Good Privacy (PGP) – the first thing the religious police would do is get someone to pretend to be a convert, and if you tell them to use PGP then all 17 people who use it in Pakistan will be arrested. They have to use something such as Skype, because there are millions and millions of users."

■ Closer partners

Figures suggest that the UK has little trouble getting data from US firms, with Google, for example, reporting that it provided data for 72% of 1,535 requests made by UK officials in the first half of last year. Such operations require protracted co-operation between countries, especially in a world where data-protection laws clash with the demands of security services.

"The problem is that countries have all passed laws that suggest they're entitled to demand data from anywhere in the world, but they've also made laws that say that no service company can disclose their own nationals' stuff," said Anderson. "This is a complete conflict of laws."

"Where this leaves organisations such as GCHQ is in a position where they have to go through mutual assistance to get, for example, data from Facebook – other than when it's a life-or-death emergency. The problem is, data is all mixed up and so the US company can't hand over US citizens' stuff. This isn't consistent with GCHQ's wish to have automated access to anything that's of interest to it."

Automated access seems unlikely, and as we've seen, there are many reasons why backdoors won't work in practice. It seems much more likely the government will strike individual deals with service providers that, under strict conditions, oblige them to hand over either the access keys or the decrypted content – with far less red tape. ●

Locked out and locked up

As part of the existing legal arsenal against encryption, Part III of the Regulation of Investigatory Powers Act 2000 requires a suspect to hand over a decryption key or put the relevant information into an intelligible form.

Failure to comply with a demand to decrypt data can lead to a sentence of up to five years for requests related to terror or child abuse (up to two years for other suspected offences), which require data to be unlocked in order to prove the case.

The legislation has already been used to imprison suspected hackers and child-abuse-image downloaders. For example, in 2010, Oliver Drage was



questioned "on suspicion of possessing indecent child images" on a hard drive that the police couldn't decrypt. The then teenager was sentenced to 16 weeks for failing to disclose his key.



The A-List

The ultimate guide to the very best products on the market today

LAPTOPS

Apple MacBook Pro 13in with Retina display Laptop, from £999

apple.com/uk

Gram for gram, the MacBook Pro 13in is a powerhouse of a laptop. An Intel Haswell CPU delivers strong performance and great battery life, the PCI Express SSD is lightning-quick, and the sumptuous Retina display is a pixel-perfect delight.

REVIEW: pcpro.link/almb13rd



SMARTPHONES

Sony Xperia Z3 Compact Android smartphone, 16GB, free phone, £22/mth, 24mths

omio.com

The 4.6in Xperia Z3 Compact is alluringly pocketable, yet combines speedy performance with decent battery life and a fine camera. The rugged, water-resistant design is a plus point too – and you get all the above for a very reasonable price.

REVIEW: pcpro.link/alsonyz3



ALTERNATIVES

Lenovo IdeaPad Yoga 2

A versatile hybrid laptop with the best IPS screen in its price range – now available at an irresistible price. **£400;** johnlewis.com **REVIEW:** pcpro.link/alyoga2

Asus Zenbook UX303LA

NEW ENTRY

Sporting the latest Broadwell Core i7, and a quality screen, this Ultrabook is both desirable and excellent value. **£700;** scan.co.uk **REVIEW:** [see p64](http://pcpro.link/see/p64)

Asus X552CL

A capable 15.6in desktop replacement. Battery life is merely okay, but there's enough power here to get the job done. **£370;** saveonlaptops.co.uk **REVIEW:** pcpro.link/alx552cl

ALTERNATIVES

Motorola Moto G (2nd Gen.)

An Android bargain with a 5in screen, good battery life and a superb design. **Free phone, £19/mth, 24mths;** omio.com **REVIEW:** pcpro.link/almotog2

Samsung Galaxy S5

A fast, weather-resistant, feature-packed phone. The camera is fantastic, too. **Free phone, £23/mth, 24mths;** omio.com **REVIEW:** pcpro.link/algals5

Apple iPhone 6

Apple steps up to a larger screen size with the classy, long-lasting 4.7in iPhone – but it's pricey. **Free phone, £31/mth, 24mths;** omio.com **REVIEW:** pcpro.link/alip6

TABLETS

Apple iPad Air 2 9.7in tablet, 64GB, £479

apple.com/uk

Even faster, even lighter and just as pretty as ever – the iPad Air 2 takes everything that made the original great and improves on it. Updated cameras and the arrival of Touch ID are welcome upgrades, too. Its only real rival is the original 32GB iPad Air, now discounted to a tempting £359.

REVIEW: pcpro.link/alipair



ALTERNATIVES

Tesco Hudl 2

Tesco's budget Android tablet sports a high-quality 8.4in IPS display. You can't top that for value. **£129;** tesco.com **REVIEW:** pcpro.link/alhudl2

Linx 8

NEW ENTRY

Part of a new wave of ultra-affordable compact Windows tablets, the Linx 8 squeezes plenty in for the price. **£90;** pcworld.co.uk **REVIEW:** [see p66](http://pcpro.link/see/p66)

Sony Xperia Z2 Tablet

The most desirable full-sized Android tablet yet, thanks to great design and battery life. **16GB, £350;** pcworld.co.uk **REVIEW:** pcpro.link/alxz2tab

PCs

Chillblast Fusion Quasar Base unit, £600

chillblast.com

Chillblast's Fusion Quasar is the very definition of a classy all-round base unit. A Core i5 CPU overclocked to 4.3GHz delivers plenty of raw power, combined with good gaming capability and serious upgrade potential. A five-year warranty seals the deal.

REVIEW: pcpro.link/alchill



ALTERNATIVES

Apple iMac 21.5in

A classy all-in-one with a compact frame, ample power and a colour-accurate screen. **From £899;** apple.com/uk **REVIEW:** pcpro.link/alimac215

Apple iMac 27in with Retina 5K display

Astonishing image quality and stunning resolution go hand in hand. **£1,999;** apple.com/uk **REVIEW:** pcpro.link/alimac275k

Armari Magnetar M18H-AW1200

NEW ENTRY

A superb workstation packed with pro-level components. **£6,594;** armari.co.uk **REVIEW:** [see p86](http://pcpro.link/see/p86)

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MONITORS

Asus PB287Q

Premium monitor, £450
overclockers.co.uk

Not so long ago, a 4K display for less than £500 was unimaginable. Asus delivers exactly that: a razor-sharp image on a 28in panel at a very reasonable price.
REVIEW: pcpro.link/alpb287q



Eizo ColorEdge CS240

Eizo ticks almost every box with the 24.1in, 1,920 x 1,200 ColorEdge CS240. With a highly colour-accurate IPS screen, it's the first truly professional-class monitor we've seen at anywhere near this price. £553; native.digital.com
REVIEW: pcpro.link/alcs240

AOC q2770Pqu

A feature-packed, 27in 2,560 x 1,440 display offering a huge workspace, an adjustable stand, a four-port USB hub – and a three-year warranty. Super PLS technology gives great viewing angles too. At this price, it's a steal. £360; dabs.com
REVIEW: pcpro.link/alq2770

PRINTERS

Canon Pixma MG6450

All-in-one inkjet printer, £80
currys.co.uk

The MG6450 inherits its predecessor's status as PC Pro's favourite inkjet all-in-one, offering high-quality output at a very reasonable price.
REVIEW: pcpro.link/almg6450



Canon Pixma Pro-100

Canon's professional-level inkjet printer is just the thing if you want prints that are a cut above the average. Produces sumptuous photographs at up to A3+ size, and its black-and-white output is stunning. £364; jessops.com
REVIEW: pcpro.link/alpixmappro

Epson Expression Photo XP-950

Epson's high-end inkjet all-in-one is a fantastic all-rounder for the enthusiast photographer. It combines high-quality prints with a decent scanner, a great touch interface and the ability to output photos at up to A3 in size. £250; pcworld.co.uk
REVIEW: pcpro.link/alxp950

ROUTERS

Netgear R7500 Nighthawk X4

AC2350 router, £187 **NEW ENTRY**
broadbandbuyer.co.uk

Top Wi-Fi performance at close range and long range, swift USB NAS performance, and all the latest Wi-Fi goodies means the new Nighthawk router takes over as our Wi-Fi router of choice.
REVIEW: see p74



D-Link DIR-868L

This 802.11ac wireless router may not have the most impressive set of features, and it lacks an internal modem. In our tests, however, it outpaced routers costing twice as much, making it an affordable way to get speedy wireless performance. £92; broadbandbuyer.co.uk
REVIEW: pcpro.link/aldir868l

Asus RT-AC68U

Hardly a value option, but Asus' flagship router offers 3x3 wireless, four wired Gigabit Ethernet ports and a pair of integrated USB sockets for high-speed file sharing. Cloud-based access and synchronisation tools are a bonus. £176; broadbandbuyer.co.uk
REVIEW: pcpro.link/alac68u

HOME NETWORKING

Synology DiskStation DS214play

Network attached storage, £296
ebuyer.com

A hugely versatile NAS with built-in Wi-Fi and some of the best media-streaming and cloud features we've seen, as well as eSATA and USB extensibility. It packs a lot of power into a solid, compact unit.
REVIEW: pcpro.link/alds214play



Netgear ReadyNAS 314

This NAS drive isn't cheap, but it's fast, reliable and easy to use – while offering advanced features such as unlimited block-level snapshots and iSCSI thin provisioning. The best buy is the diskless model. £412; ebuyer.com
REVIEW: pcpro.link/alrnas314

Google Chromecast

This is the future of TV streaming – cheap to buy and simple to use. Plug the Chromecast into a spare HDMI port at the back of your TV, then browse on your smartphone or tablet and beam Full HD content directly onto the big screen. £30; play.google.com
REVIEW: pcpro.link/alccast

WEARABLES

Pebble Steel

Smartwatch, £150
firebox.com

The Pebble Steel isn't the flashiest smartwatch out there, but it offers great battery life, brilliant apps and a simple interface with solid physical controls. Plus, it supports both iOS and Android.
REVIEW: pcpro.link/alpebblesteel



LG G Watch R

Android Wear smartwatches don't tend to have great battery life, but the G Watch R is the best we've seen. With an attractive, round-faced design, a punchy and colourful display and a heart-rate monitor, it's the best Android smartwatch so far. £177; amazon.co.uk
REVIEW: pcpro.link/algwatchr

Sony SmartBand Talk

NEW ENTRY
Sony's SmartBand does more than most fitness trackers: it displays notifications, allows you to answer phone calls, and its E Ink screen contributes to above-average battery life. £115; dabs.com
REVIEW: pcpro.link/alsonysmart

SECURITY SOFTWARE

Kaspersky Internet Security 2015

Another year, another excellent performance.

It's super-secure, lightweight and unintrusive.

3 PCs/1yr, £25; store.pcpro.co.uk

REVIEW: pcpro.link/alkasis15



Avast Free Antivirus

Still the best free antivirus, although others are catching up. It offers dependable protection – and it doesn't nag you about upgrading. **Free;**

avast.com

REVIEW: pcpro.link/alavast15

Norton Security 2015

It isn't the cheapest, but the protection provided is good and it covers up to five devices, from laptops to tablets and smartphones.

5 devices/1yr, £34; amazon.co.uk

REVIEW: pcpro.link/alnort15

PRODUCTIVITY SOFTWARE

Microsoft Office 2013

Microsoft retains the top spot for the ultimate office suite, although tablet users may be disappointed by lacklustre touch support.

From £110; office.microsoft.com

REVIEW: pcpro.link/aloffice13



LibreOffice 4

The UI looks a little dated, and Microsoft Office has the edge on features. All the same, LibreOffice is an impressively powerful office suite – and it won't cost you a penny.

Free; libreoffice.org

REVIEW: pcpro.link/allibreoffice

Scrivener

A brilliant package for serious writers: not just a word processor, but a tool that helps you organise your ideas and manage the process of composition from start to finish. **£29;**

literatureandlatte.com

REVIEW: pcpro.link/alscrivener

CREATIVITY SOFTWARE

Adobe Creative Cloud

The licensing model won't suit everyone, but Adobe's suite of creative tools is second to none, covering everything from photo and video editing to web development.

Complete plan, £46/mth; adobe.com

REVIEW: pcpro.link/alcccloud14



Adobe Photoshop Elements 13

Adobe's home image-editing tool is a terrific and powerful buy, although users of older versions won't find much reason to upgrade.

£69; amazon.co.uk

REVIEW: pcpro.link/alelements13

Steinberg Cubase Pro 8

A big bump in performance and a handful of UI improvements keep Cubase at the top of the audio-production tree. A worthwhile upgrade.

£390; dv247.com

REVIEW: pcpro.link/alcubasepro8

SERVERS

HP ProLiant DL80 Gen9

NEW ENTRY

Massive storage capacity combines with a high-speed Xeon E5-2600 v3 CPU and a scalable design to push this HP rack server to the top of the tree. The price is very reasonable as well. **£989 exc VAT; hp.co.uk**

REVIEW: see p102



HP ProLiant MicroServer Gen8

A space-saving microserver with excellent remote-management features that's perfect for even the smallest of businesses – and it's reasonably priced, too. **£154 exc VAT; ebay.com**

REVIEW: pcpro.link/alhpgen8

STORAGE APPLIANCES

Qnap TS-EC880 Pro

Qnap's eight-bay desktop NAS sets new standards in the desktop NAS appliance space, combining ultra-powerful hardware with every storage feature you could wish for. It has huge expansion potential, and 10GbE networking seals the deal. **Diskless, £1,249 exc VAT; ballicom.co.uk**

REVIEW: pcpro.link/alec880pro



Synology RackStation RS2414RP+

Built with speed and expansion in mind, this 2U rack NAS offers a veritable feast of storage features and plenty of expansion potential. It's good value, too.

Diskless, £1,337 exc VAT; ballicom.co.uk

REVIEW: pcpro.link/alrs2414rp

SECURITY

WatchGuard Firebox T10-W

Packed with wired and wireless security features, the T10-W includes IPS, web-content filtering, application controls and HTTPS inspection. The box acts as a dual-band wireless AP, too. **From £485 exc VAT; watchguard.com**

REVIEW: pcpro.link/alfireboxt10w



Sophos Cloud

User-based policies and slick mobile support make this a top-class cloud solution. Performance is impressive, too. It's not the cheapest option, but it's a pleasure to use. **10 users, £510/yr exc VAT; sophos.com**

REVIEW: pcpro.link/alscloud

BUSINESS PRINTERS

Epson WorkForce Pro WF-5620DWF

Shatters the myth that inkjets are only for low-demand use, delivering fast output speeds, low running costs and tons of features. It prints at 20 pages per minute, and quality is perfectly acceptable – it can even print glossy photos. **£182 exc VAT; printerland.co.uk**

REVIEW: pcpro.link/alwvf5620



HP Officejet Pro 8620

A top-class business inkjet all-in-one with low running costs and top-quality colour output. Not the fastest, but it packs in the features. **£144 exc VAT; misco.co.uk**

REVIEW: pcpro.link/alhp8620

BACKUP

Barracuda Backup Server 290

A beautifully simple appliance that brings together on-site and cloud backup. There's block-level deduplication, extensive support for Windows systems and applications, integral Exchange MLB and simple deployment and management.

£4,446 exc VAT; barracuda.com

REVIEW: pcpro.link/alserver290



MozyPro

An affordable cloud backup service for desktops and servers that sets the standard for deployment and management. It will handle parallel local backups for faster restores. **50GB/1yr, £154 exc VAT; mozy.com**

REVIEW: pcpro.link/almozypro

NETWORK MANAGEMENT

NetSupport Manager 12

Release 12 of this indispensable support tool brings a new PIN Connect feature for instant connections and a redesigned console that makes it easy to manage a large number of PCs. Android and iOS are supported via apps, and the price is a one-off fee rather than a subscription, so it's superb value.

250 seats, £28 per seat exc VAT; netsupportsoftware.com

REVIEW: pcpro.link/alnetsupport



Paessler PRTG Network Monitor 12.4

Licensed by the number of sensors, and with a proprietary database included, PRTG is a great-value auditing and monitoring tool with no hidden costs.

500 sensors, £881 exc VAT; paessler.com

REVIEW: pcpro.link/alprtg124

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Profile

BACKGROUND INFO ON INNOVATIVE BRITISH COMPANIES

WANdisco

This is a technology firm like no other. Not only did it solve an unsolvable problem, it also took the reverse journey from Silicon Valley to Sheffield



KEY FACTS

WANdisco IN A NUTSHELL
WANdisco's patented technology allows companies to keep multiple copies of the same data synchronised in data centres across the world, delivering "absolute business continuity".

LOCATION Dual headquarters in Sheffield and San Ramon, California

FOUNDED 2005

EMPLOYEES
More than 200

WEBSITE
wandisco.com

RIGHT WANdisco's code can replicate data housed in different data centres in real-time

The chances of someone inventing the data-duplication technology behind WANdisco are roughly the same as someone in a parallel universe thumbing through a copy of *PC Pro* like you are now. At least, that's if you believe the company's charismatically bullish CEO David Richards.

The straight-talking Sheffield man still talks with awe about the day Dr Yeturu Aahlad turned up in his office and explained how he had "invented the impossible" – a way to keep two sets of data, stored in two different parts of the world, in perfect synchronicity with one another.

That one idea was enough to persuade Richards and his partner to drop their plans to launch a private equity fund and instead create WANdisco, which has since grown into £100 million firm with more than 200 staff based around the world, including development centres in Sheffield and Belfast.

WANdisco has been on the cliché "roller-coaster ride" since it went public in 2012, its share price initially soaring before tumbling back to a third of its peak. Richards can barely conceal his anger at how British investors fail to appreciate his company's potential, and it's not the only thing about the British tech scene that infuriates him, either.

■ Silicon Valley start

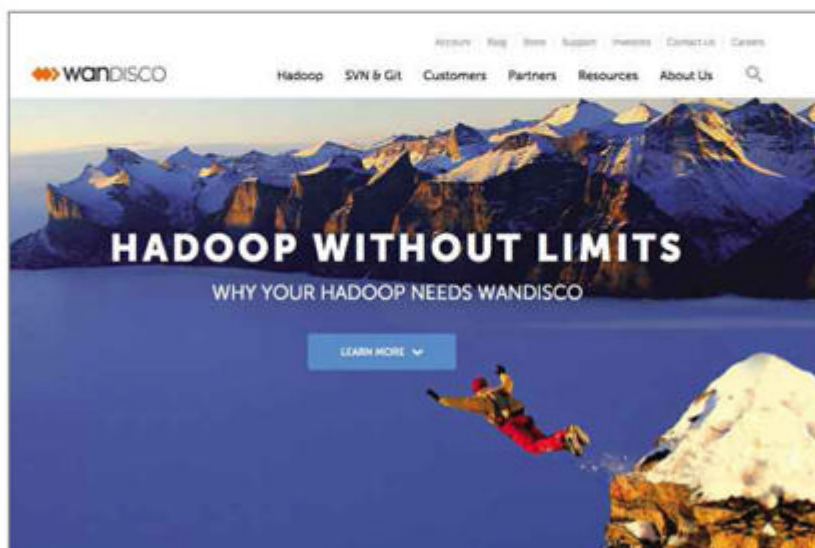
Although it now has headquarters in Sheffield, WANdisco started life in San Francisco. Attracted by the internet boom underway in Silicon Valley, Richards packed his suitcases and headed west, starting and selling two technology firms in the space of ten years. He was on the verge of using the proceeds to set up his own equity fund to "invest in the uninvestible – geeks who had really, really clever ideas", when one such candidate walked through the door: Dr Yeturu Aahlad.

"Aahlad had solved, in 20 pages of hieroglyphs, one of the most complex problems in computer science, which I just couldn't believe," Richards told *PC Pro*. "He'd taken the idea to multiple venture capitalists, but they hadn't got a bloody clue what he was talking about. What he'd done was to reinvent the way the internet worked at the very highest level. The internet is basically a client-server system with multiple points of failure, which is why we see outages all the time. What he'd done was invent active-active WAN replication, using something called the Paxos algorithm, which is a massively complex bit of code."

Unlike the other venture capitalists Aahlad had met, Richards was a computer scientist, and although he admits Aahlad's concept stretched beyond the limits

of his knowledge, he understood enough to know he was onto something big. With Dr Aahlad's patented code, Richards realised you could replicate data housed in different data centres in real-time, providing the loss-free failover that data-critical businesses would kill for. So he scrapped his plans to set up the equity fund and, in 2005, formed WANdisco (short for wide area network distributed computing), designed to meet the big data needs of companies running the open-source storage framework, Hadoop.

"Despite failures, despite low bandwidth, despite distance, and despite having a wide-area network in the way, we can guarantee that data exists in more than one place





ABOVE WANDisco has headquarters in Sheffield



RIGHT David Richards gave up plans to set up an equity fund in order to invest in WANDisco

“Companies that don’t realise data is a fundamental source of competitive advantage across every single industry will fail”

at the same time,” said Richards. “We’re talking about vast quantities of data, we’re talking about whole data centres’ worth of data, we’re talking about something the size of Google’s dataset.”

Banks are now using WANDisco’s technology to safeguard multibillion-dollar trading systems; hospitals are using it to sync patients’ medical records; UCL is even using the technology to predict cardiac arrest in patients two or three days before it happens. “It’s now possible for a credit company to look at all of your transactions and multiplex that against what you’re currently doing – to figure out if it’s really you using your credit card with a very high probability, which they’ve never been able to do before,” said Richards. “Queries that used to take two to three months to run are now moving down to milliseconds.”

“Data really is the new oil,” Richards added. “Companies that don’t realise that this is a fundamental source of competitive advantage across every single industry will fail. They just will fail.”

■ The secret sauce

How is it possible to sync terabyte upon terabyte of data across international boundaries in an instant? It isn’t, but it is possible to

quickly sync the metadata that identifies where the actual data blocks are stored, ahead of replicating the data itself.

“Let’s say you have a change that’s about to happen in data centre A,” said Richards. “Before that change actually happens, data centre B and data centre C know about that change, and a global sequence is maintained at every single data centre. The agreement that takes place, which is based on Paxos, sounds like it’s going to take forever to do, but it’s minuscule, it’s imperceptible, the payload on each transaction is almost zero.”

But what happens if you run a query in data centre A before the data that’s been changed in data centre B has been fully copied across to A? “To us, that doesn’t matter,”

said Richards. “The net effect of what WANDisco does is to create a single logical global cluster of data. So even if the data hasn’t arrived from data centre B to data centre A, data centre A still understands where that data is in its replication cycle. So it’s not eventual consistency, it’s complete consistency, because all the metadata lives simultaneously in every data centre.”

■ Coming to England

Three years after Richards met Dr Aahlad, the company expanded to the point where it needed its own software-development centre. Richards chose his hometown of Sheffield, disproving the idea that you need to be in driving distance of Shoreditch to build a successful tech start-up in Britain.

He describes the government’s attempt to drive tech businesses towards the capital’s Silicon Roundabout and later Tech City as “the worst marketing ever”. “It needs to be Tech UK, and I think to be fair to the government... they have [now] done that and said come and run your HQ in the UK.”

Richards says the UK offers one of the most business-friendly tax and investment regimes of any country. However, he’s frustrated by the deficiencies in the education system. “The university system in the UK doesn’t generate relevant, current graduates, and that’s a real problem,” he said. Forcing students to choose certain A-levels to do computing degrees “stops many, many careers of people who would be superb computer scientists, because they don’t study mathematics A-level and they’re finished... we specialise too early.”

He also despairs of university courses, saying only Belfast knows how to prepare students for life in industry. He believes Tech City’s “dirty secret” is that many computer-science graduates are recruited from Eastern Europe, while their British contemporaries remain unemployed because they don’t have relevant skills. “I spoke to the head of computer science at one of the English universities, and he asked me what Hadoop was. I wanted to hit him over the head. How on Earth can you not know that? He was teaching Pascal – I mean...” We won’t print exactly what he said after that.

■ Share price slump

University lecturers aren’t the only thing to rile Richards. WANDisco’s shares were trading at a third of their 2013 high at the time of writing, which Richards blames on the UK investment community’s failure to place the right value on growing tech companies. He says the market is waiting for WANDisco to sign up more lucrative customers – which he promises are coming – instead of looking at the company’s long-term potential. WANDisco wouldn’t have this problem if it was listed on the NASDAQ, Richards argued, which is somewhat ironic for a company that’s all about replication across international borders.

“Our focus is on building unique technologies to attack a trillion-dollar marketplace, to take market share very quickly,” said Richards. “Right now, I’m not focused on profit. I’m focused on becoming a massive company with huge value in that space. The real value of the company isn’t the current market cap. Not even close.”

Still, turning an idea scribbled on 20 sheets of A4 paper into a company worth £115 million hasn’t been a bad decade’s work so far. **BARRY COLLINS**

What about you?

Do you work for a British technology company that could be profiled in PC Pro? If so, get in touch: profile@pcpro.co.uk



Viewpoints

PC Pro readers and experts give their views on the world of technology

Sorry Dave: the next Google won't be a Tech City start-up

The government's tech initiatives are generating headlines, but falling short where it matters most



Darien Graham-Smith is PC Pro's deputy editor. If you'd like to buy one of his many business ideas, get in touch.

Election fever isn't far off, and I'm starting to ask myself how the current government has performed. On the technology front, it's a mixed report card: David Cameron's positions on surveillance and internet censorship have been hard to swallow, but his government has also

supported some laudably open-minded initiatives, such as trials of driverless cars and innovative rural broadband schemes.

There's been a new emphasis on cultivating start-ups, too, with various loans, tax breaks and support services available online in recent years. It's easy to mock the Tech City project, but it does tap into a certain patriotic pride: the internet can feel like a very American place, so there's something seductive about the notion that the next big thing could be British.

In truth, it's quite a stretch to imagine a new internet colossus rising in Shoreditch. Yes, British enterprise has achieved many amazing things, and doubtless can again. But the next time some bright spark does come up with a fresh and compelling new service, doesn't it seem almost inevitable

that one of the incumbent giants will simply swoop in and buy it?

Indeed, that's the outcome many start-ups hope for. The fast-moving nature of the industry encourages a short-term game plan. Meanwhile, more long-haul ventures are finding that once they outgrow the various start-up schemes on offer, institutional support dries up. To continue expanding, several young businesses have told us they plan to relocate to – you've guessed it – the US. Who can blame them?

I don't mean to tar all start-ups with the same brush. Plenty of small businesses mature into sustainable concerns, and make a net contribution to their local economies. Overall, though, it's a risky market.

Commercial insurer RSA (not to be confused with the cryptography body of the same name) tells us that 55% of British small- and medium-sized businesses fail within five years. You have to wonder whether the government's tech-friendly initiatives really count as investing in the economy, or whether they might more properly be characterised as gambling.

Perhaps there's another way. If you read last month's magazine, you may recall that PC Pro readers voted Sir Tim Berners-Lee – inventor of the World Wide Web – as their

“If we want to cultivate the next Google, there's clearly an argument for funding stable research environments”

number-one computing hero. Berners-Lee's work benefited from taxpayer support, but not through the modern means of start-up grants and tax breaks. When he created the web, he wasn't on the payroll of any business: he was employed at CERN, funded by a group of European governments in the name of scientific research.

He's far from an isolated case. Vint Cerf developed TCP/IP while researching communications technology at DARPA, a branch of the US Department of Defense. Alan Turing's work began with state-funded research at Cambridge. Google, while not directly government-supported, grew out of research carried out by Sergey Brin and Larry Page while working on their PhDs at Stanford.

So if we want to cultivate the next Google, there's clearly an argument for

funding stable research environments, rather than the rough and tumble of start-up culture. Sadly, the rhetoric coming out of Tech City leaves me wondering whether this really is what the government wants. Its public statements trumpet growing numbers of digital businesses, yet seem to show little interest in what they're actually achieving. It's hard to avoid the impression that the goal is to foster not sustainable enterprises but favourable headlines.

The ivory towers of academia don't hold all the answers either, of course. If you tried to build an innovation industry along the lines of some of the university departments I've worked in, you might end up with quite a likeable Radio 4 sitcom, but probably not a rival to Microsoft.

But it's telling that many large technology organisations operate their own research centres. Unix was created at Bell Labs – the R&D subsidiary of a private telecoms company. Laser printing, Ethernet and the mouse-driven user interface came from Xerox's Palo Alto Research Center. Today, Microsoft Research in Cambridge employs around a thousand full-time researchers, while HP Labs partners with organisations including CERN. Clearly, investment in research, with a focus on

long-term returns, is compatible with a business brief.

And it isn't as if the prime minister is unaware of such ventures. At last year's CeBIT expo, Mr Cameron proudly announced a joint project between King's College London, the University of Surrey and Dresa University of Technology,

focusing on the eminently commercial business of developing a new 5G telecoms network. But when PC Pro then went digging for the details, we learnt that none had been finalised and no state support delivered.

The digital economy is tremendously important to the UK, and it deserves proper stewardship. Fostering a sink-or-swim start-up culture may create buzz, and might even promote third-party involvement in the digital sector, but it's no substitute for sustained and directed investment. Whether anything like that will be on the table in May remains to be seen – but if it is, I'll count it as a very promising sign. The real test will be whether that support continues once the press releases have dried up and the newspapers have moved on to another story.

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So long, and thanks for all the Superfish

In the cutthroat world of Windows laptops, it isn't only crapware you have to worry about



Deputy reviews editor
Sasha Muller may have been injected by malware that causes him to consume beer, fish and chips – all the time.

From politicians to laptop makers, it seems everyone is looking for a way to earn some pocket money. In the week that saw Jack Straw and Malcolm Rifkind caught in Channel 4's "cash for access" sting, Lenovo found itself implicated in the Superfish debacle; the revelation that,

unbeknown to its customers, the company had been secreting security-busting adware in its laptops.

Despite Superfish Visual Discovery sounding more like a drunken late-night encounter at the local chippy than a piece of software, the reality is rather more malign. The company responsible for Superfish's talents, Komodia, was doing something very dangerous indeed.

Users had been complaining about the software since September 2014, but it took until February this year for security experts to reveal the full implications of Superfish's payload. It wasn't merely preinstalled crapware designed to pop up the occasional advert; it was third-party software that hooked into Internet Explorer and Chrome at such a low level that it could inject adverts into both search results and websites.

So dubious are its methods, in fact, that the software came bundled with a variety of unpleasant side effects. The more innocuous was Superfish's ability to break the rendering on certain websites with its adverts; the real show-stopper was that it left machines vulnerable to man-in-the-middle attacks, the implications of which proved staggering.

Superfish goes about its business by installing a self-signed root HTTPS certificate, which means its ad-spewing

mechanism is inveigled into the path of encrypted traffic on any website and via any browser. Affected users would imagine their data was secure when visiting an HTTPS website – for instance, their bank account – but, instead, Superfish's own certificate would be masquerading in the place of the official website's genuine certificate.

The coup de grace? In a security no-no of epic proportion, the encryption key for Superfish's certificate turned out to be the same for every afflicted Lenovo machine. The result, as confirmed by Robert Graham, CEO of Errata Security, was that attackers could use the Superfish Transport Layer Security certificate to intercept encrypted communications from any affected laptop, and potentially even use the compromised certificate to validate phishing sites.

To add insult to injury for Komodia and Lenovo, Graham went on to prove just how serious a problem Superfish was. First, he underlined the firms' laissez-faire attitude to security by cracking the encryption key inside three hours – hilariously, this turned out to be "Komodia". And second, he demonstrated how easily he could take advantage of the vulnerability by cobbling together a Raspberry Pi 2, a \$15 Wi-Fi adapter and a microSD card to rig up a rogue Wi-Fi hotspot capable of snavelling the data from any Superfish-laden machine (see pcpro.link/247komodia).

The hope that this might have been an isolated incident soon faded away in the days following the revelations. The fallout from the Superfish debacle saw researchers such as Facebook's Matt Richard identify 14 other software applications, all of which use the same compromised Komodia code. Others went as far as to identify rootkit technology lurking at the heart of the code, designed to hide the software's machinations from the attention of the operating system.

So, who's to blame? Lenovo surely deserves stick for its handling of the affair – initially, the company seemed reticent to admit how serious a misstep Superfish was, and didn't cover itself with glory when the company's CTO first passed the buck to the engineers working under his watch: "They missed this".

And, to my mind at least, it doesn't feel like an engineer-vetted decision in the first place; it feels like one borne of a Lenovo executive who was attempting to claw back a few precious cents from the scant bottom-line profit of today's laptops, and who simply didn't grasp the security impact. Take a look at just how much money most Windows PC and laptop makers get per unit (clue: unless you're Apple it's rarely enough to buy a round in the pub), and the question becomes why they haven't broken out of PCs and gone into the used-car business.

Which may make you wonder how the new breed of sub-£100 Windows tablets (see p66) are even worth making. In large part, it's because Intel is subsidising the cost of its Atom processors and

Microsoft is bundling the OS for free, as both play catch-up in the tablet sector. Unless those giants can step in and do something similar for middle-tier laptops, it won't belong before the other big brands follow Samsung and Sony and abandon the cutthroat laptop market altogether – and that won't be good for anyone.

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An adorable example of how to teach tech

A four-year-old offers lessons on tech education – and battling Ender Dragons



Nicole Kobie is PC Pro's Briefing and Futures editor. You can find her playing Minecraft under that Auntie Coco moniker.

Teaching tech at school is hard. Schools have limited budgets and long refresh cycles, meaning kit is often out of date. Teachers have to invest much of their own time into staying on top of areas as disparate as programming and Microsoft Office in order to keep up with students, let alone

lead them. And even with such efforts, most of the skills students acquire will quickly be out of date.

Despite such challenges, many children are fairly well advanced at tech, being exposed to a multitude of devices in the home: my four-year-old niece hasn't even hit school yet, and she's already familiar with a smartphone, tablet and laptop.

The disconnect described above was the cornerstone of much discussion at the Bett education technology show in London in January (see p14). There seems to be a feeling that if we don't get the tech curriculum and IT procurement correct today, then British students will fall behind in the global economy when they try to get jobs ten or 20 years from now.

But it's impossible to say what technology people will be using at the end of this decade, let alone by the time today's primary school students are ready to join the workforce. That niece of mine, Sofia, already has her own iPod touch and access to a laptop; 20 years from now she might be wearing a tenth-gen HoloLens – or, more likely, something we

“So dubious are Superfish's methods that the software came bundled with a variety of unpleasant side effects”

can't even imagine. Do you remember what the state of technology was 20 years ago? Google didn't even exist. This summer will mark the eight anniversary of the first iPhone. At this rate of change, it's impossible to predict what life will be like in 2035.

Perhaps it's time we concerned ourselves less about teaching specific skills, such as the now-compulsory programming in a text-based language. Instead, we should focus on showing students how to learn, how to be curious, and not to be afraid of new things, in the field of technology or otherwise.

I'm convinced of this after a lesson from my niece. Sofia loves Minecraft, and she's far better at the block-building game than I am – she hasn't only figured out that there's a subterranean Nether world, but she knows how to access it and deal with the local dragons. I was astounded when watching her play – I had no idea any of this even existed.

I asked her where she had learned all of this, and (stupidly) whether she used the Minecraft Wiki, which is my own usual method of figuring out what on earth is going on in the game. Her response: "Don't be silly Auntie Coco – I can't read. I saw it on YouTube."

After I'd overcome the shock of a child making me feel so terribly stupid, I realised that's quite the lesson for how to teach tech. Sofia's only four, and she's already figured out how she can access useful information online and apply it to achieve a goal – and she isn't scared of failing at something new.

That last point is key: adults constantly lament the fact they're lacking technology skills, but what's stopping them from acquiring them? Even education secretary Nicky Morgan repeatedly pointed out in her Bett keynote how tough it was for her generation to keep up with technology. If a four-year-old can do it, Nicky, surely government ministers can too.

School's primary role is to encourage and channel this attitude and ability. Forget teaching students how to use a computer, because those lessons will be out of date by the time Sofia gets to her first real job. Instead, teach her how to adapt.

Many teachers I've spoken to are already doing this, helped by cheap, creative tools such as the Raspberry Pi (see p62). Their students are lucky, since they'll be the ones founding the next Google, not just using it. I hope my niece Sofia is fortunate enough to be taught by such a teacher. That said, please also teach her how to read – that Minecraft Wiki really is dead handy.

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Augmented reality is on its way – beware sleepy holo

You can't truly escape reality because, despite your senses, you're never truly in it



Dick Pountain, editor of Real World Computing, plans to crowdfund an AR app that will replace cosmetic surgery.

With TV news full of crashing airliners, beheadings and artillery bombardments, it's hardly surprising that people wish to escape into a virtual reality under their control – a virtual reality becoming ever more possible.

The miniaturised components required for smartphones are precisely those whose lack has been holding back VR for the past few decades: displays, graphics processors, high-bandwidth comms and batteries. The embarrassing withdrawal of Google's Glass project suggests that gaming remains the principal application for this tech, and Microsoft's HoloLens goggles confirm that Redmond is thinking the same.

The HoloLens employs huge mobile GPU power to mix 3D holographic images into your normal field of view, creating an augmented, rather than virtual, reality effect: you see what's really there, combined with whatever someone wants to insert.

“Could AR objects stray out of the perceptual model into memory and become permanent residents of the psyche, like ghosts?”

It's an exciting development with many implications for future UI design, but it may create problems too – because we already live in a naturally augmented reality. You might think that everything you're seeing right this second is what's “really” there, but in fact much of the peripheral stuff outside your central zone of attention is a semi-static reconstruction of what was there a few seconds ago: like yesterday's TV sets, your eyes lack sufficient bandwidth to live-stream HD across their whole field of view. That's because evolution had no access to silicon, gallium arsenide or metallic conductors; it had to make do with warm salty water.

But that's the least of it, because *everything* you see is a reconstruction and none of it is directly “live”. Your visual cortex reads data from the rods and cones in your retinas, filters this data for light, shade, edges and other features, and uses these to identify separate objects. These objects are inserted into a constantly updated model of the world stored in your brain, and that model is what you're seeing as “really” there. Everything is already a reconstruction, which is why we're occasionally prone to hallucinations and optical illusions.

There's more. The objects that get accepted into the world model aren't neutral, but – like your memories – get a tag recording your emotional state, in the strict biochemical sense of hormone and neurotransmitter levels, when they were added. This world map in your brain is value-ridden, full of nicer and nastier places and things. You maintain a similar brain model of your own body and its functions, and the US neuroscientist Antonio Damasio believes the mystery of consciousness will one day be solved in the way these twin mappings are superimposed and analysed in the brain. We're still a long way from such a solution.

Neuroscientists aren't the only people who understand this stuff. Painters, sculptors and moviemakers know perfectly well how visual representations and emotions are connected: some spaces, such as dungeons, are just creepy; some faces are admirable, others irritating. A horror film such as *Sleepy Hollow* – to justify this column's weak pun – is already a primitive form of augmented reality. Most of what appears on the screen depicts real stuff such as trees, sky, people, furniture and buildings, and only a few parts are unnatural CGI creations. Since all are only 2D, however, the brain has no trouble distinguishing them from “real” objects. That will no longer be the case with the new holographic, 3D augmented-reality systems.

The cruder kinds of early VR system I wrote about years ago – those ones where you staggered around in circles wearing a coal scuttle on your head – suffered noticeable problems with motion sickness, because their entirely artificial and laggardly background scenery violated the physics of people's inner-world models and upset their inner-ear balance. It seems likely that augmented-reality systems of the calibre of HoloLens may escape such problems, being utterly physically convincing because their backdrop is reality itself. But what completely unknown disorders might AR provoke? Could AR objects stray out of the perceptual model into memory and become permanent residents of the psyche, like ghosts that people will in effect be haunted by? Will we see epidemics of PLSD (post-lucid stress disorder)? And as for AR porn, the potential for embarrassing encounters doesn't bear thinking about...

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Readers' comments

Your views and feedback from email and the web

Restoring from the cloud

I'm writing in response to M Jones' email "Backing up isn't enough" (see issue 245, p28). Having been both a Windows and OS X user for more than 20 years, I've come across a number of backup processes that claim to restore your PC to its original state – the most impressive of which has to be Apple's Time Capsule. Recently, I needed to restore my own Windows system from a backup, after experiencing a Blue Screen of Death and wisps of smoke from my motherboard. A new desktop was purchased, but with a smaller SSD, so my backup wouldn't fit.

Since this was Windows 8, however, that wasn't an issue. I provided my Microsoft Account details and 15 minutes later I had my desktop, apps, browser extensions, bookmarks and history all there. I have since refreshed the desktop with Windows 10 Technical Preview and it does the same thing. As long as your music, videos and documents are safely stored on a separate drive, Windows 8 and Windows 10 will automatically restore your desktop and apps. I no longer use regular backup software, instead using services such as Dropbox, Google Drive and OneDrive for backing up important documents and photos. **John Roberts**

Deputy editor Darien Graham-Smith

replies: "It's worth noting that only Modern apps are linked to your Microsoft Account: desktop programs such as iTunes and Photoshop won't be synchronised in this way. However, Microsoft is already working on porting Office to the new app framework, so we're moving towards a situation where only personal data files need to be backed up – and that's got to be good news."

Time for banks to join the 21st century

I've been using the Bank of Scotland for my business banking for the past few years, and have used only internet banking to administer my account. This week, however, I had cause to contact the bank (to enquire about a business banking product) and was amazed to find that there's no way to contact the Bank of Scotland's Business Internet Banking team via the internet! You can telephone or write to them, but there is no email address, no online contact form and no live chat. Thinking that I must have

Star letter

I wonder what excuse Apple-haters will find to explain the company's record profits (announced last month). I guess they can always claim that the rate of stupidity is a constant percentage of the population – so, as the world population grows, Apple will always find more fans to buy its products!

What makes me happy is that it was thanks to Bill Gates, who still believed in Apple back when it was almost bankrupt, that the company survived and grew beyond anyone's wildest dreams. Will Apple become more like Microsoft, as it continues to grow? In spite of its huge profits, its market share is tiny. Windows still overwhelmingly dominates the PC world, so, unlike the Microsoft of the 1990s, Apple can't afford to take a break: it must constantly compete ferociously to keep that highly profitable slice of the market.

All this makes you think. I believe that Apple might shrink its revenues and profits for 2015, compared to super-2014: it's almost impossible to believe it can keep beating its own records, even if the market isn't saturated yet. But it's getting tougher to push Apple products to Apple-haters. Apple doesn't need new iPhones, iPads or Macs: it needs a radically new product to address a completely unexplored niche, and I don't think the Apple Watch is that product (although it will still sell like hot pancakes). Maybe the company needs to address the new market opened by the Surface, and merge iOS and OS X in a single operating system and launch an iPad Air with a keyboard and a stylus.

Or maybe something even more completely unexpected. Who knows? Does Tim Cook still channel Steve Jobs? **Gwyneth Llewelyn**

This month's star letter wins a Corsair Force Series LS 120GB SSD worth £75. Visit corsair.com



missed a link on their site, I tweeted an inquiry to @AskBankOfScot – who confirmed that "it isn't possible to contact the team via email, sorry".

Come on guys – please try to embrace this new-fangled technology. I think this internet malarkey might just catch on, you know! **Mike Hall**

Leaving classic cars in the dust

I've no wish to denigrate the excellent work done by Nick Dale in his car design (see issue 246, p116), but as a fairly ancient PC Pro reader I found it interesting to note the similarity between Mr Dale's design and those of the C- and D-Type Jaguars of the 1950s. The point of course is that modern technology can dramatically reduce design costs – and in this case drag coefficients as well, to nearly a third of the D-Type. **Mike Kitley**



RIGHT Mike Kitley believes Nick Dale's prototype has a hint of Jaguar inside

Don't overlook Lumia

It was nice to hear some positive comments about the Windows Phone UI on this week's podcast (episode 346). I went out to buy a phone thinking I was going to get a Galaxy S-something, but ended up with the Lumia because I preferred the UI – I haven't regretted my decision. If I had to go out tomorrow and buy another phone it would be a Windows Phone.

To continue on the Nokia theme: given your comments on the same podcast about music, I really like the MixRadio application that came with my phone. Give it some artists, and then give "thumbs up" and "thumbs down" ratings to songs and it does a good job of keeping me entertained. It throws in wildcards every so often, to give you the chance to listen to new songs and widen what is streamed to you. It seems to keep up with what's popular, too – for me, it plays more



recent than older music. I know it's not alone in what it offers – but in my opinion, it's very good. **Shaun**

Kaspersky pricing

I liked your review of Kaspersky Internet Security 2015 (see issue 246, p88), but when I visited the provided Ebayer link I was unable to find the product at the £20 price stated. I contacted Ebayer asking how I could purchase at this price and received a response as follows:

"The prices for items on our website fluctuate on a daily basis. This can be for different reasons, such as some items being sourced from other warehouses, or the cost price to us may be less, so the item can be sold at a lower price."

I know that caveat emptor applies, but when you review the software at £20, I feel we should be able to purchase at your recommended price. Many thanks for a good read – despite the cost differences! **Peter Rawbone**

Reviews editor Jonathan Bray replies:

"We're as disappointed as you about the price rise. Unfortunately, as Ebayer points out, prices can vary daily – sometimes in the customer's favour, and sometimes not. Even at the higher price, however, rest assured that Kaspersky remains our favourite of the paid-for security suites. See the A-List for the new price and supplier."

Tommy Flowers: setting the record straight

I'm a volunteer at Bletchley Park and The National Museum of Computing. Regarding your Unsung Heroes feature (see issue 246, p42), Tommy Flowers' Colossus had nothing to do

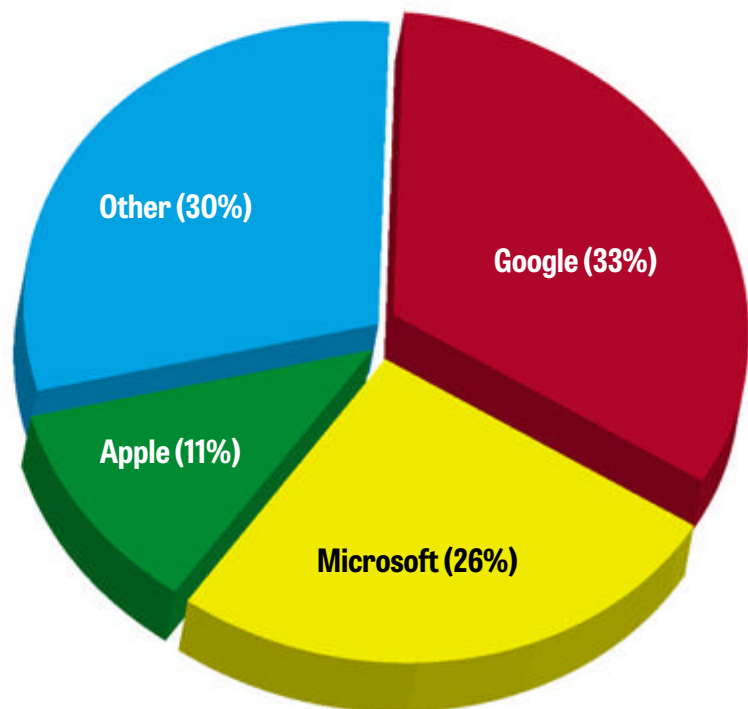
Enigma had been cracked by Turing and others years before Colossus was built

with Enigma. It was designed and used to find the wheel settings on the Lorenz SZ42 cipher machine. So it's incorrect to say that "without Colossus, Turing and his team would have struggled to crack the Enigma code" – Enigma had been cracked by Turing and others years before Colossus was built. **Sheridan Williams**

Davey Winder replies: "Mea culpa. Flowers and his Colossus were, however, instrumental in cracking the Tunny codes, which were used by Hitler from 1942 onwards. I certainly didn't intend to slight Turing, but rather to emphasise that Flowers played an equally instrumental role in the war effort. Apologies for the confusion."

Readers' poll

We asked you: which technology company would you most like to work for?



Perhaps ironically, readers seeking creative work environments were overwhelmingly attracted to Google and Microsoft, while the perceived high-pressure culture of Apple proved less enticing. Outside the "big three", votes were split across a broad spread of organisations, including IBM and Samsung, thanks to the diversity of their offerings, and Oracle – on the reasonable basis that, if you're looking for a new career, a degree of stability isn't the worst thing in the world.

“Microsoft is currently the most innovative company out there. Google is too random in what it produces”

“I'd choose Oculus: they're going to affect almost every industry in the coming decade”

“Google is at the top of its game, but still going places. You get the sense it's motivated by more than mere shareholder value”

“Apple asks what the future could be, rather than copying others”

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HOW TO BUILD A 21st CENTURY CLOUD

4D is an independent UK data centre and ISP with a successful cloud platform. So why reinvent the platform from the ground up?

4D isn't the kind of provider that sits back and keeps its portfolio ticking along. Nor does it just pay lip service to the idea of listening to its customers: it genuinely engages with the businesses it works with, and then uses that feedback – combined with its own insight and expertise – to build platforms and solutions that support customers' business needs.

4D has recently launched a new cloud services platform, redesigned from the ground up to match the changing requirements of its clients. We spoke to its founder and technical director, David Barker, about the new cloud platform, and the thinking and work that went behind it.

■ You've had a successful cloud platform in place for the past few years. Why did you feel it was time to redesign it?

We did a recent review of the service: how clients were using it, and the applications they were running. It revealed that there was a diverse range of applications running on the platform, and that we had many clients looking for a hybrid cloud – that is, somewhere they could run multiple applications within our platform and also connect back into the colocation racks in our data centre, or link them to their offices using leased-line and point-to-point connections.

■ Did you find companies had a wide mix of needs?

Absolutely. Some of our clients are looking to store data long-term, but don't need constant or immediate access. Others require high



David Barker is the founder and technical director of 4D, an independent UK data centre, cloud provider and ISP

performance and want to run a database from an SSD. We needed to look at how we could accommodate them all, and we also wanted to support developers looking for more development-specific environments.

■ What's different about the new platform?

The main differences are on the storage side. We've redeveloped the whole storage network and gone for 10Gb iSCSI throughout. Our new SAN enables us to use any number of drives of different types in one unit and split them up, so we can offer one customer 5GB on SSD, 100GB on a 15K SAS and 500GB on a 10K SAS. This gives more flexibility per customer, and it all

scales up to 10 petabytes, so we have plenty of room to grow.

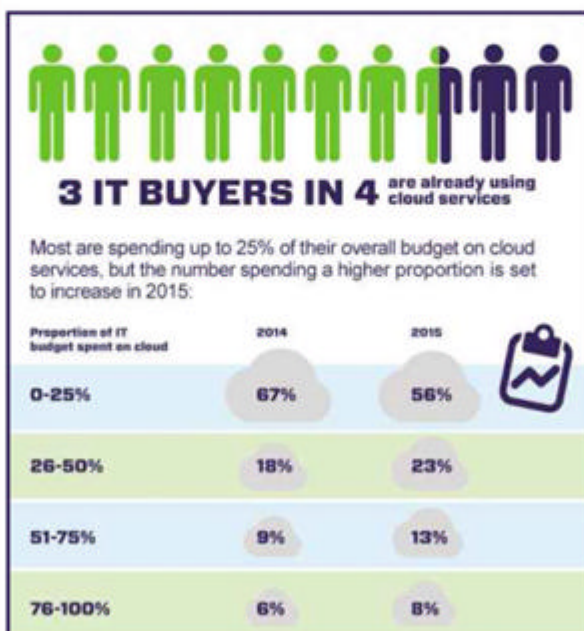
Plus, within our new cloud platform, customers can spin up virtual machines (VMs) and have an external network connecting to the internet, or they can set up private networks between the VMs, bring in a leased line and connect those machines directly back to the office. That allows customers to migrate their back-office applications – Active Directory, Exchange and so on – onto the platform, but it will still feel as if it's running on their local network.

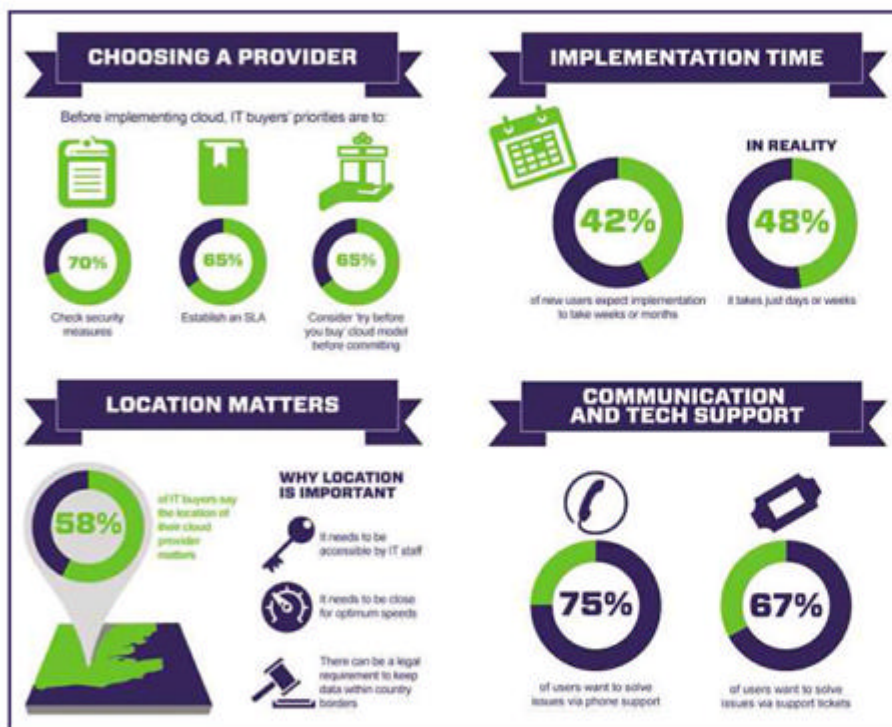
■ So they get the flexibility and scalability of the cloud, but with the performance of local infrastructure?

Yes, and they also get more resilience. Changes extend to the hypervisors. We've put more cores and RAM in per hypervisor, and added local storage, with a distributed SAN running the OS for the hypervisors so they have the same access to the Windows or Linux system files that they'd have within a physical machine. That stops some of the lag you see when the hypervisor has to get out to the SAN and back again for paging and other OS functions. It's still distributed, though, so if one hypervisor falls over, another can access the same files and storage.

■ Are there other changes that make the new platform easier to work with?

We have a new control panel and UI, which makes tasks such as firewalling and configuring VMs much easier. We have a full template library of pre-configured operating systems, so that when a customer logs in they can





get a Linux machine with Apache, MySQL and PHP to spin up in minutes – and we can also offer other configurations hardened for specific surfaces, so that customers can spin up a secure web server without having to worry about configuration. They can then configure it with their own applications and customise it, then back it up and template it. That way, if they want to set up a similar server for another project, they can just go back to their own template library, grab the template they created six months ago, and build another one.

■ The new cloud platform sounds compelling, but why should potential customers choose 4D?

Partly our track record. We've been in the hosting business for 16 years, and always had the ethos that the service we sell should be something we'd want to buy. We take care of the little

things, like making sure there's a toolbox with a screwdriver available when a customer is in the data centre at 3am. It's the same with our cloud platform. We've made sure that the things that, with other cloud platforms, could be annoying, are either eliminated or made simpler, with help and documentation provided.

It's also service. When a customer wants cloud infrastructure we sit down with them beforehand and look at what they want to put into the cloud platform. We make sure it's correct, because you don't want to run everything on a cloud platform; some things are better off on physical hardware. We help clients with the whole process of migrating onto the cloud, and make sure that it works perfectly for them.

For a personalised cloud solution call 020 7183 0602 or visit 4d-cloud.com

Five benefits of the new 4D cloud platform

1 Flexible & scalable

4D's new cloud platform runs a number of operating systems on a wide range of virtual server configurations. The new Infortrend SAN and architecture makes it even easier to scale your cloud infrastructure on demand. Whether you need to spin up multiple environments in seconds or store critical data for a number of years, the new cloud platform can meet your demands and grow to suit your needs.

2 Private & secure

There are many layers of security for the platform itself, between users on the cloud, the VMs and the network traffic. These include four layers of firewalls, private vLANs for network traffic, enhanced security templates and customisable user permissions. Additional security features enable users to meet more stringent requirements such as PCI DSS.

3 Fast & resilient

Hypervisors now use a distributed SAN to run the OS, ensuring that virtual servers perform more like physical machines, while replication across physical hardware means that hypervisor failure won't affect service or availability.

4 Easy to use

A new UI and control panel and optimised processes make it easier to configure, start and secure virtual machines, back them up and template them, or add in virtual firewalls and other infrastructure. Meanwhile, an extensive template library makes it even faster to build common virtual machines, including hardened systems for use online.

5 Location matters

Remember, location matters when ensuring optimum speeds – you'll want to reduce latency to your cloud. There can also be a legal requirement to keep data within country borders. 4D Cloud is based in its independently owned Surrey data centre, which is ISO27001 accredited. The centre is just off the A3 and M25 and 30 minutes from London (by rail), so external auditors can easily assess its facilities.

Win a trip to the clouds in a hot air balloon!

To win just answer this one simple question:

Where is 4D's flagship data centre – the home of its UK cloud operations? Top tip – you can find the answer on the 4D website: 4d-cloud.com

Email your answer to balloon@4d-dc.com by 12 April 2015

The winner will be announced on 4D's website and LinkedIn page on 20 April 2015. To find out more about Virgin balloon flights visit virginballoonflights.co.uk

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Prospects

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Give your PC a health check

How Speccy Professional can help keep your PC in top condition **p34**

Protect your devices from theft

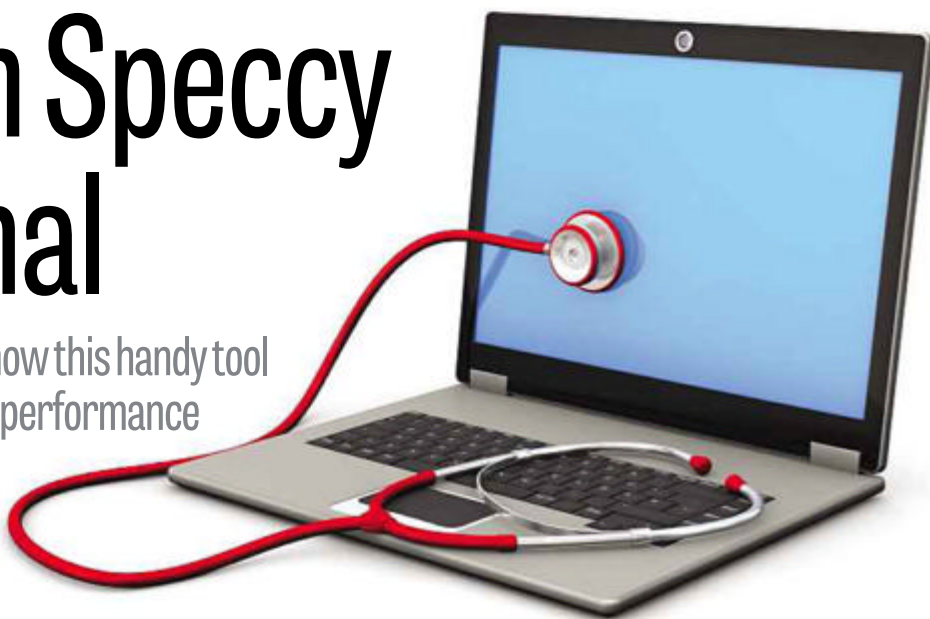
Keep laptops and smartphones safe with our practical advice **p38**

Careers

The busy life of an IT support engineer **p40**

Give your PC a health check with Speccy Professional

Darien Graham-Smith discovers how this handy tool can help you improve stability and performance



It's easy to take a computer's health for granted, but as with our own wellbeing it makes sense to keep a regular eye on key health indicators – and that's where tools such as Speccy Professional, included with the download edition of this month's magazine, prove their worth.

Speccy is a tool for auditing your PC's components and settings, including many details that aren't otherwise accessible within Windows. And there are many reasons you might want to know what it has to say. It can help you identify when your system isn't operating at peak performance. It can provide a valuable early warning if things aren't working as they should, so you can take action before failure strikes. And, if you're looking to sell your system, it's a great way to list exactly what's inside.

Here, we provide a step-by-step health check of your PC, using Speccy as our guide.

Keep that CPU cool

When you open Speccy Professional, you'll see an overview of your OS and your PC's main components. You can click the individual headings at the left to open up a detailed view of the various aspects of your PC.

Start with the CPU view: here you'll see the technical details of your

processor, with small blue arrows next to section headings that can be clicked on to reveal additional detail.

You'll also see the processor size, shown in nanometres: CPUs made to a smaller scale are more electrically efficient, so they can run at higher speeds without drawing too much power and overheating.

Indeed, it's temperature that's of key importance in this pane. The ultimate concern is that if your CPU is

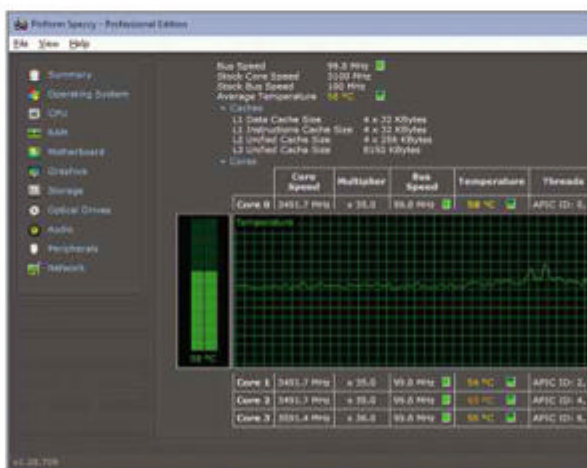
BELOW If your system is unstable, your CPU could be overheating. Keep an eye on its temperature in Speccy Professional

running too hot for prolonged periods, it could become damaged. In practice, processors tend to simply shut down when they get too hot – so if your computer is overheating, it's likely to become unstable.

Different chips support different temperature ranges, but the "junction temperature" (that is, the maximum) for a modern CPU is normally between 90°C and 100°C. If your CPU is often up around here, it's cause for concern.

Even if your processor isn't getting so hot as to shut down, too much heat can affect your PC's performance. If your CPU features Intel's Turbo Boost technology, it won't kick in – or will do so only to a limited extent – if the chip is above a certain temperature, to avoid overheating.

Speccy Professional shows the average temperature inside your CPU, colour-coded from yellow to red to give an at-a-glance idea of whether you should worry. If you click the two-tone green icon next to the temperature readout, you can see your processor temperature as a live



graph; try running different programs and see how this affects temperatures.

For a more detailed look, click to expand the Cores section and you'll see the speed and temperature of each physical core in your system, as measured by the chip's internal sensors. You can also see if Turbo Boost is doing its job, as the frequency multipliers jump up and down in response to system load.

If your temperatures appear too hot, there may be a simple explanation – check whether your PC's vents are blocked, as airflow is crucial to cooling. Also check the fan speed as reported by Speccy Professional: this shows the spin rate of the internal fan tasked with keeping your CPU cool. A spin speed of around 1,000rpm is normal, even when the computer's idle, and we'd expect to see two or three times that rate under heavy load. If it's showing as very low or zero, it suggests a hardware fault.

SMART storage

The second stop in our check-up is the Storage pane, which displays a breakdown of all the drives installed in your system. Again, a huge amount of technical information is available here: for a mechanical disk, the spindle speed, measured in RPM (revolutions per minute), affects how quickly the disk can fetch data, while Power On Time gives you an idea of just how long the disk has been in use.

You can also see the Maximum Transfer mode supported by the disk, and the transfer mode it's currently using. If your disk supports SATA III 6GB/sec, but is using only SATA II, you probably aren't getting the full performance of which it's capable. Check your BIOS to see if you can enable the faster transfer mode – or, in the case of a desktop system, see if you can connect it to a different SATA connector to get the full speed.

As with the CPU, temperature is key here. Manufacturers cite

SMART attributes

	Attribute name	Real value	Current	Worst	Threshold	Raw Value	Status
01	Read Error Rate	0	118	118	50	000BFD73BA	Good
05	Retired Block Count	2	100	100	3	0000000002	Good
09	Power-On Hours (POH)	143d 22h	0	0	0	000000007E	Good
0C	Device Power Cycle Count	135	100	100	0	0000000087	Good
A8	Program Fail Block Count	1	0	0	0	0000000001	Good
AC	Erase Fail Block Count	0	0	0	0	0000000000	Good
AE	Unexpected Power Loss	101	0	0	0	0000000065	Good
B1	Wear Range Delta	2	0	0	0	0000000002	Good
B5	Program Fail Count	1	0	0	0	0000000001	Good
B6	Erase Fail Count	0	0	0	0	0000000000	Good
BB	Reported Uncorrectable Errors	0	100	100	0	0000000000	Good
C2	Temperature	38 °C	38	48	0	0000300026	Good
C3	On the fly ECC Uncorrectable Error Count	201,159,610	120	120	0	000BFD73BA	Good
C4	Reallocation Event Count	2	100	100	3	0000000002	Good
C9	Uncorrectable Soft Read Error Rate	201,159,610	120	120	0	000BFD73BA	Good
CC	Soft ECC Correction Rate	201,159,610	120	120	0	000BFD73BA	Good
E6	Life Curve Status	100	100	100	0	0000000064	Good

temperatures in the range of 50°C to 60°C as too hot for a mechanical disk, while SSDs can normally go a bit hotter: Samsung, for example, says its SSDs will work at temperatures of up to 70°C. We've seen SSDs continue to work happily at much higher temperatures, but we'd be wary of doing this regularly: if an SSD fails, it's all but impossible to recover the data.

The Storage tab also lets you view the SMART data for each drive. SMART stands for Self-Monitoring, Analysis and Reporting Technology, and it's basically a means for drives to keep an eye on their own health, and warn you when they're close to failing. Your BIOS should warn you when a disk reports a warning, but it's reassuring to be able to check for yourself.

Naturally, SMART can't give you advance warning of every type of failure – sometimes, components just go pop out of the blue. But the warnings it does give are important.

By default, Speccy Professional's "SMART attributes" table is collapsed, because it's likely to contain several dozen entries, depending on the drive type. Some of these have rather obscure names (such as "wear range delta" and "life curve status"); if you want, you can read up on the various

LEFT You can dig into your hard disk's self-reporting data and check its health for yourself

BELOW Find out how fast your memory is running, and how many slots you have free for an upgrade

RAM

Memory slots

Total memory slots 2

Used memory slots 1

Free memory slots 1

Memory

Type DDR3

Size 4096 Mbytes

Channels # Single

DRAM Frequency 796.7 Mhz

CAS# Latency (CL) 11 clocks

RAS# to CAS# Delay (tRCD) 11 clocks

RAS# Precharge (tRP) 11 clocks

Cycle Time (tRAS) 24 clocks

Command Rate (CR) 1T

Physical Memory

Memory Usage 87 %

Total Physical 3.38 GB

Available Physical 585 MB

Total Virtual 14 GB

Available Virtual 4.01 GB

SPD

Number Of SPD Modules 1

Slot #1

Type DDR3

Size 4096 Mbytes

Manufacturer Kenya Technology

Max Bandwidth PC3-12800 (800 Mhz)

Part Number NT4GCS4B5HG0NS-DI

Serial Number 26AC37D

Week/year 26 / 12

Timing table

	Frequency	CAS# Latency	RAS# To CAS#	RAS# Precharge	tRAS	tRC	Voltage
JEDEC #1	580.0 Mhz	5.0	5	5	14	19	1.500 V
JEDEC #2	437.1 Mhz	6.0	6	6	16	22	1.500 V
JEDEC #3	533.3 Mhz	7.0	7	7	18	24	1.500 V
JEDEC #4	609.5 Mhz	8.0	8	8	22	30	1.500 V
JEDEC #5	685.7 Mhz	9.0	9	9	24	33	1.500 V
JEDEC #6	761.9 Mhz	10.0	10	10	27	37	1.500 V

SMART attributes and learn how to interpret the reported values (see pcpro.link/247smart).

All you really need to know, though, is that a failure in any SMART category represents an unfixable physical problem with the disk. Take the opportunity to back up your data and order a replacement drive.

On the topic of storage, if your system has a DVD or Blu-ray writer, this will be detailed in Speccy Professional's Optical Drives section. We're past the days when DVD-writing performance mattered greatly, but this pane also shows you a breakdown of all the disc formats your drive can read and write, including DVD-RAM, DVD-R, DVD+R and Blu-ray media. Optical discs are still popular for archival, so it's handy to know which disc formats you can use – and whether you can take advantage of dual-layer, double-capacity media.

Memory speed

One aspect of performance that's easily misunderstood is RAM speed. Click the RAM tab and you'll see full

Take control of your Windows settings

As well as revealing the inner details of your hardware, Speccy Professional can deliver insight into the state of your operating system too. Click to open the Operating System pane and you'll be presented with a huge report, detailing your Windows Update settings, antivirus status, power profile and much more.

Two entries are particularly revealing. Under Scheduler, you'll find details of all the processes that have been set to run automatically at periodic intervals on your computer – these may include automatic updaters for installed applications, and nag screens that ask you to upgrade bundled software to the full edition. You can remove these items within the Windows Task Scheduler – indeed, you can audit them here too, but normally it's a case of out of sight, out of mind.

The other section that's well worth a look is Security Options. Speccy Professional collects together 95 important settings that are normally buried away in the Group Policy Editor, or otherwise accessible only by trawling through multiple Control Panel settings.

For system administrators, it's extremely handy to have these settings all in one place, along with the hardware and networking information provided by Speccy Professional. Even home users should glance down the list: for example, it's worth checking that "Guest account status" is set to Disabled so that unauthorised users can't connect to your PC remotely. "Only elevate executables that are signed and validated" is likely to be Disabled, but you might want to enable it to provide an extra layer of security.

details of your memory, starting with how many free RAM slots your PC has. If you're considering upgrading, this means you don't need to dig out a screwdriver to discover your options.

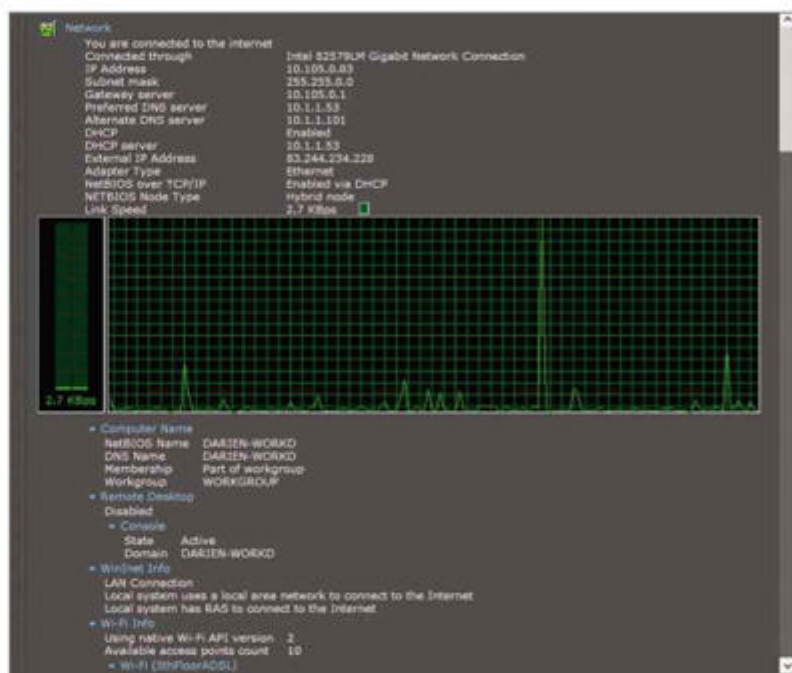
Below this you'll see performance details. The speed of your RAM is given in megahertz; if you're using DDR3, then the effective speed will be double this frequency (thanks to the dual data-rate from which the standard takes its name). If the speed seems lower than it ought to be, you can adjust this in the BIOS, and even overclock your DIMMs if you wish. In our tests, however, we've found the benefits of faster RAM to be minimal.

Below this, you'll see a selection of RAM-timing figures, measured in clocks. The meaning of these may not be instantly clear, but they reflect the fact that memory cells don't fetch and store data instantly; timings indicate how many clock cycles it takes for memory operations to complete. If you expand the SPD section, you'll see a table indicating how many clocks of latency to expect when the DIMM is run at various frequencies. Again, it's technically possible to force a DIMM to use faster timings, but the benefit is likely to be minimal – and you may experience data errors when the module can't keep up.

What's happening on your network?

Speccy Professional's primary focus may be hardware specifications (hence the name), but it also brings together all sorts of information about your network connections, so it can help you improve the speed, reliability and security of your network.

RIGHT Monitoring your real-world network throughput can help you optimise your home LAN



At the top of the Network pane, you'll see a breakdown of your internet settings, including your external IP address, which you need to know if you want to host an internet service such as an FTP server inside your home network.

You'll also see your current link speed, which you might be surprised to see is constantly fluctuating. When Windows reports your link speed, it only shows you the nominal rate of your connection, which might be 100Mbps/sec for a wired Ethernet link or, say, 130Mbps/sec for a wireless connection. Speccy Professional reports exactly how much data is going up and down the pipe, so you can check your real-world throughput

(you can view this as a graph as well). With a laptop you can even start to download a file, or copy it across your home LAN, then walk around and see how the speed varies in different parts of your home – or perhaps move your router to improve the signal.

If your computer is equipped with wireless, you'll also see details of all the wireless networks in range. You can see their relative strength – expressed as a percentage, rather than using the vague system of bars that Windows prefers – and the frequency and channel number of each, so you can check whether your own network is clashing with anyone else's.

If there are few networks around, it's recommended that you use a channel as far away as possible from the others, as Wi-Fi channels actually overlap (this is why you'll see advice telling you to stick to channels 1, 6 and 11 in the 2.4GHz range where possible). Unfortunately, interference doesn't only come from other wireless networks; it may take some trial and error to escape interference from other electrical appliances.

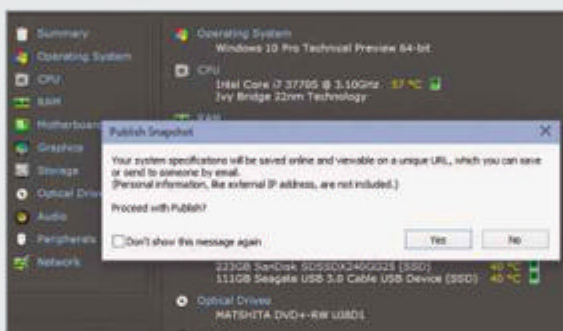
At the bottom of the pane, you'll see a section headed Current TCP Connections. If you've ever wondered whether the software on your PC is "phoning home", this is where you'll find the answer. Click to expand it then click on a process name and you'll be shown the IP address where it's connected to, along with a name where available.

Hopefully there won't be any nasty surprises here, but if you've accidentally installed some sort of spyware, or an application that you simply don't trust, you can see exactly what it's up to here – and then use a firewall to selectively block it. ●

Save and share system information

Speccy Professional isn't only for examining your PC in-place: it's also useful to save or share system information – for example, if you're selling a PC, seeking technical support or auditing PCs. Select "File | Save Snapshot..." and enter a filename to save a SPECCY file another user can inspect on their own PC using either Speccy Professional or the basic free Speccy package.

If you prefer, you can share a snapshot of your system configuration with a friend or colleague directly over the web, by selecting "File | Publish Snapshot...". This will generate a report and host it for you at **speccy.piriform.com**, from where you can simply share the URL. There's no privacy protection here – anyone with the address can see the details of your PC – but since the address of the page includes a random 23-digit code, it's unlikely anyone is going to stumble across it by chance.



A last option worth mentioning is the ability to export a snapshot as XML. This could be helpful for IT managers, who can collect structured reports from multiple machines and then easily collate and analyse hardware and system information about entire departments.

ABOVE It takes only a few clicks to post your detailed system specifications online, for easy sharing

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Protect your valuable devices from theft

Don't be a victim of opportunist crime. **Mike Bedford** investigates how best to keep your laptops, tablets and smartphones out of the wrong hands

Laptops, smartphones and tablets are terrifically useful tools – but they're also valuable items that attract thieves. On these pages, we'll consider two approaches to reducing your risk of being a victim of theft. First, we'll advise on how small behavioural changes will lead to greater safety of your mobile devices. Then we'll investigate the various types of anti-theft products aimed at this sort of equipment, and examine the pros and cons of each. If the worst does happen, we'll also examine what is and isn't covered on standard insurance policies – and whether there's any benefit to taking out a specialised policy intended for this type of device.

Much of the advice given here is with the business user in mind, but that's only because they arguably have more to lose; it's perfectly applicable to personal use too.

■ What do you have to lose?

It's easy to ignore nagging concerns, and imagine that loss and theft happens only to other people, but according to security and communications company ViaSat, and based on data obtained from Freedom of Information requests to the UK's police forces, there were almost 300,000 thefts involving computer equipment between March 2013 and February 2014. This figure doesn't include mobile phones: a recent Home Office report covering the same period suggests that there were almost 750,000 victims of handset theft in England and Wales alone.

In order to make informed decisions, it's important to consider the potential cost of a theft. Most obvious is that of replacing the stolen hardware; you might hope and expect that this will be covered by insurance, but there are excesses and exclusions to consider – and, as we'll see later, there's even the possibility that equipment you thought was covered by your insurance policy isn't actually



Image: Danny Bird

protected outside of your home or office. Given that a smartphone can cost more than £700, and a top-end laptop aimed at the business user around £1,500 or more, these are losses that can't be ignored.

Significant as these costs might be, they pale in comparison to the less tangible potential losses, especially for business users. First among these is the cost of losing data stored on your stolen device. As a business, you have a legal obligation to keep customer data secure, so if that data is stored unencrypted on a laptop that's stolen, you could face legal consequences (see p106).

Even if you're in the clear legally, there's the possibility of consequential losses resulting from sensitive data falling into the wrong hands. There's also the productivity cost of lost information to consider:

while it's great to have a regime of backing up data on a desktop PC, on removable storage, or in the cloud, this doesn't always negate the loss. There's a limit to how frequently it's viable to back up, so there's always a risk of losing a day's

work, or the valuable information gleaned in the meeting you've just walked out of.

Consequential losses go beyond the loss of data too. In business, time is money, so if the loss of

your laptop means you're unable to work effectively until it's replaced, that could represent a considerable cost to your business. If those days of reduced productivity happen to fall within a business trip abroad, there's the cost of wasted flights and accommodation to add to the

"In business, time is money, so if you're unable to work effectively until equipment is replaced, it represents considerable cost"

ever-growing tally. Finally, but no less importantly, don't forget that someone stealing your phone can rack up a huge bill if you don't promptly report it to your network operator as stolen.

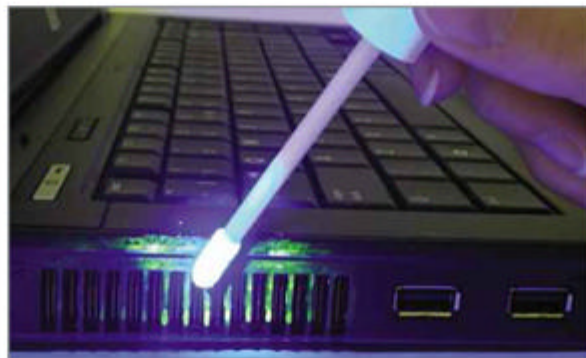
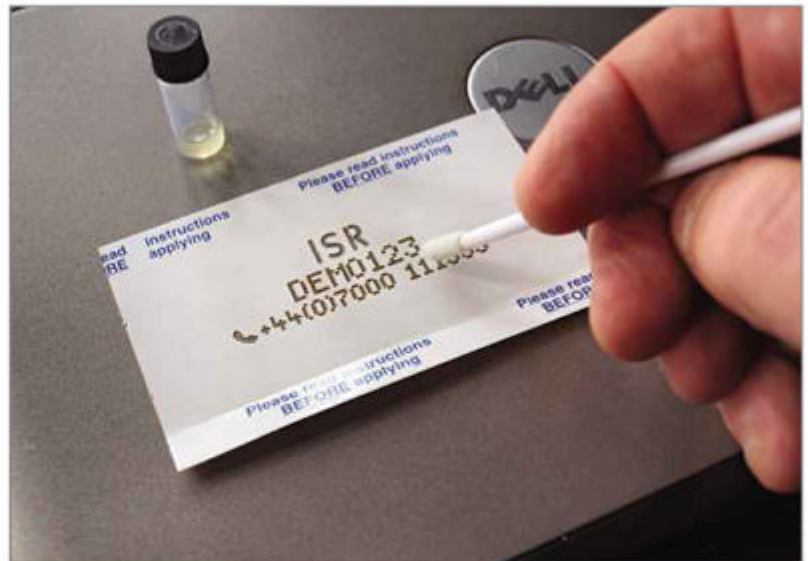
Behavioural changes

You can do a lot to protect your devices from theft simply by making some minor behavioural changes. Some are common sense, but may be easily forgotten in the business of everyday life. Others might be ones you may never have considered.

One of the simplest but most effective ways to reduce the risk of theft is to avoid advertising your kit to potential burglars. If you really must leave anything unattended in a vehicle, put it in the boot, rather than on display on the passenger seat. If you're walking down the street, there's no reason to have your phone in your hand. The few seconds it will take to remove it from a pocket or handbag as needed isn't going to result in many missed calls – and the maxim "out of sight, out of mind" certainly applies from the perspective of the would-be thief.

It might seem more difficult to conceal a laptop when you're out and about, but one possible measure that's been recommended to us by a police crime-prevention officer involves carrying it in a scruffy supermarket carrier bag, rather than in a posh case. After all, who would ever suspect a carrier bag contained an expensive laptop? If you can't bring yourself to degrade your laptop in that way, at least buy a laptop backpack. It's much harder for a thief to rip one of these off your back – especially if you choose one with a waist strap – than it would be to wrest a conventional case from your hand.

RIGHT You can apply a unique serial number to your equipment



ABOVE SmartWater enables you to paint marking onto your equipment, making it easier to identify if it's been stolen

If you can't disguise the fact that you're carrying expensive electronic equipment, make sure it's always in sight. Most people wouldn't dream of leaving a laptop unattended on a bus, tube or commuter train, but it's an all-too-common sight on intercity trains. You might feel a little neurotic carrying it around with you to the onboard shop or toilet, but that scenario is better than having to admit to your boss that you've had a laptop stolen.

Even if your equipment stays in view at all times, it's a good idea to make it as difficult as possible for a potential thief to approach you unnoticed, so that an opportunist can't snatch your hardware and sprint off. Sometimes it's necessary to work in public environments, which isn't ideal, but if you do have to set up office in a busy coffee shop, try to sit with your back to the wall or, better still, in a corner.

Identification markings

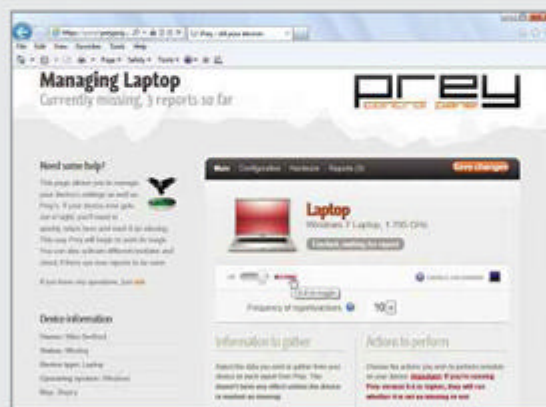
Anti-theft hardware comes in a variety of forms: some products aim to discourage criminals from attempting to steal your equipment, while others aim to make it difficult for them to do so; some even sound an alarm if they try. There are also products that aim to help you recover your possessions if they're stolen; then you're into damage-limitation territory. Your data, at the very least, is still at risk unless you've enforced encryption.

Protect with Prey

If the worst should happen, and your laptop, tablet or smartphone is stolen, it may not necessarily be lost for good. There are various utilities available that use a device's geolocation capabilities to track it down: these include Apple's "Find my device" service and Google's Android Device Manager.

A more integrated option is a software utility called Prey, which provides a single dashboard from which you can track Android, iOS, OS X, Windows and Linux devices. What's more, since it doesn't cost a penny, there's no good reason not to give it a try.

To set it up, simply visit preyproject.com, install the software and register each device in



turn. Thereafter, if a device is subsequently stolen, simply flag it as such on the Prey website. After that, whenever the stolen

equipment is switched on, Prey uses the identity of nearby Wi-Fi access points to pinpoint its location. You can then view periodic reports online, showing you the location of your equipment, screenshots that might be informative or incriminating, and perhaps even with a photo of whoever has been using your equipment.

If this doesn't result in its recovery, you have other options at your disposal: you can instruct Prey to sound an alarm on your equipment and warn the user that they are being observed – or, alternatively, offer a reward for its return. However, it would probably be wiser to issue a command to lock the laptop to ensure any sensitive information doesn't fall into the wrong hands.

When it comes to discouraging thieves, the normal method is to mark your equipment in some way. Since this identifies the equipment as yours, it becomes much harder for a thief to sell it on – and they won't want to have it hanging around, since it could be incriminating.

One popular product in this category is SmartWater (smartwater.com), which you simply paint onto your kit. Its presence can be detected by the police using an ultraviolet light and, if an item is shown to be marked in this way, it can be analysed by the manufacturer to discover its precise chemical formulation. Since every customer is sent a unique batch of SmartWater, this positively identifies the owner of the equipment. SmartWater itself isn't normally visible, so it's supplied with warning labels that you stick onto your equipment.

Simpler approaches include identification stickers that attach using strong adhesive, which is impossible to remove without leaving telltale signs. You can also obtain kits containing stencils and specially formulated ink that etch an identification code into the body of the equipment. Some products mark the equipment with a name and postcode (such as idmark.com); others apply a unique serial number that is associated with the owner in a database (retainagroup.com). The advantage of this approach is that it needn't reduce the secondhand value of the equipment, since the new owner can be registered in the

database. Depending on how conspicuously you want to mark your device, these codes can be placed unobtrusively on the bottom of a laptop; there's more reticence to place these on phones, but products with smaller text are available.

Physical locks and alarms

Most laptops have a Kensington lock slot – a connector named after the laptop security company (kensington.com) that, for more than 20 years, has made steel cables that secure the computer to some immovable object. Tablets and smartphones rarely have security sockets, but cases with a Kensington slot are available for some tablets, as are Kensington slot anchors that can be attached to such devices using extra-strong adhesive.

Other cable-based security solutions, such as the Lock Alarm Mini (lockalarm.com), use a thinner cable and sound an alarm if anyone tampers with or cuts through the cable. The Mobile Laptop Alarm NB-3500p from Trust (trust.com) works along similar lines, but

LEFT The Lock Alarm Mini will sound an alarm if anyone tampers with, or cuts through, its cable



using wireless technology: a tag is attached to the laptop, and you place the corresponding key fob in your pocket. If the tag is separated from the key fob by 5m or more, the alarm sounds.

For smartphones and tablets, it's also possible to obtain key fobs that track the devices using their built-in Bluetooth connection, so you don't need a separate tag – see, for example, the Kensington Proximo Key Fob Bluetooth Tracker. These devices won't prevent a thief from grabbing your laptop or phone in the first place, but it's unwise to rely on only a single means of protection, and alarms can make a useful addition to the mix.

Insurance

Strictly speaking, insurance isn't about preventing theft, but mitigating its impact. However, part of protecting yourself against the risk of theft is ensuring that your equipment is covered. We spoke to the British Insurance Brokers' Association (BIBA), which provided the following advice.

First, don't assume that equipment will be covered under either your home contents or business policy when it's away from those places. Some contents insurance policies can be extended to cover this, but do check first. If you use your own personal equipment for work, it too may not be covered under your home contents insurance, although it may be protected under your employer's policy. Most policies also won't cover you if you leave your property for a

“Most insurers impose a single-item limit – a maximum amount they will pay for an individual item, regardless of its value”

long time, usually around 30 days in a row. The bottom line is, if you've taken out a standard policy and haven't checked what's covered, you're setting yourself up for a nasty surprise.

You should also be aware that most insurers impose a single-item limit – a maximum amount they'll pay for any individual item, regardless of its value. If that's a problem, you may be able to take out a specialised gadget insurance policy, covering more expensive single items and offering quick replacements for important portable items.

Finally, most standard business insurance policies won't cover the loss of data and productivity, although specialist policies exist that will cover these losses as part of business interruption. Businesses looking for specialist insurance should speak to a broker so they can find a policy that covers their needs. BIBA runs a “find a broker” service, which you can contact on 0870 950 1790. ●

LEFT Track tablets and smartphones via Bluetooth keyfobs



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Ben Simpson

IT support engineer



■ What does your job involve?

I'm a senior support engineer at an IT support consultancy called Microbyte (microbyte.co.uk). We're based in Peterborough, with a second office in Basingstoke, and we work with a variety of small- and medium-sized businesses. I handle daily support requests from these companies; my jobs might range from sorting out printing issues to setting up Wi-Fi and internet access, as well as more complicated tasks such as configuring guest networks, provisioning broadband lines and VoIP services, and even building new servers and migrating data across from older systems.

■ What does a typical day look like?

The first thing I do when I get into the office is look at my tasks for the day: we use a bespoke call-management system to assign tasks to specific engineers. We have a chap in-house who develops and does all the programming for that, so if we need to fix or change something, we can make that happen. It's a good way to work; if you use out-of-the-box software, you'll still need to pay for training, and if it doesn't perfectly fit your needs, it might not be possible to go back to the creator to get it changed.

Most of the machines we support have remote-access software installed, so I can often complete my tasks from the office. Sometimes, though, you need to visit a customer's premises: I'd say I spend approximately five hours a week on site, excluding travel time. Outside of office hours, I might also be on call, so – for example – if any requests come in between midnight and 8am, I can deal with them right away.

■ Is there much out-of-hours work?

If you want to work a 40-hour week it's possible; if you want to get stuck in, then there's an opportunity to put in 18 hours a day too. Everybody's so passionate here that there's plenty of out-of-hours work going on, even when there's no extra pay going for it. There are many occasions when you turn up to the office at 9am to find your colleagues have been there for two hours already. It's a committed environment – there are nine of us working in the same room, so everybody's really engaged with everything that's going on.

■ How did you get started in IT support?

I've always had an interest in PCs and networked systems. Since the age of 12 or 13, I used to build computers at home, and made myself little networks. At college I gained a BTEC National Diploma in Multimedia, so that tied into my interest in technology, although it probably isn't directly relevant to how I ended up in this role. On my return after some time spent travelling, I found that a friend was already working here. He knew I was the sort of person who often stayed up until the early hours playing with PCs just for personal interest, so he suggested I apply for a job, and it all worked out.

I started off as a junior support engineer – everyone here begins with simple work such as call logging, and taking care of small jobs such as resetting passwords and setting up basic profiles. At six months, an evaluation follows where they see if you've shown commitment and dedication, and whether you can deal with all the different types of job that come in. If all goes well, you can then move up to a senior position, take on more responsibility and start doing regular out-of-hours work.

£16k
Approximate
starting salary

2,898
Permanent jobs
(itjobswatch.co.uk)

£31k
Average
earnings

■ What advice would you give to someone interested in working in IT support?

Obviously you need a degree of technical expertise, and the ability to keep up with the technologies being used by your customers. You also need to be good on the phone – an effective support engineer needs excellent questioning skills, and also an ability to think laterally to work out what the customer actually means, rather than what they're telling you. Personally, I enjoy the challenge of trying to get to the bottom of what's causing the customer's problem.

■ What's the pay like?

Around here, junior staff tend to come in at around £16,000. Seniors such as myself go up into the £20,000 region, and once you get further involved in big projects, you might be looking at £40,000 or more. There's also the potential to generate work off your own back – you might land a contract with a customer to carry out a specific project, and receive a bonus for that, or the opportunity to earn some overtime. That can apply even if it's something we don't normally deal with: recently, for example, a colleague was talking about the possibility of putting up dishes on a radio mast to extend the range of a wireless network. Two days later, it's in the office being configured. So if you have an idea, or there's something you hear about, we have the opportunity to give these things a go. ●

Where to start

- **Microsoft Exam References** (pcpro.link/247careers): learn not just the how, but also the why!
- **Online video training** (cbt nuggets.com)
- **Keep your ear to the ground on technology blog sites for the latest developments and reviews**



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* Cost comparison: One year BT Retail contract: 10 ISDN30e channels + 100 DDI quota + CLIP = £218.00 per month. Spitfire: 10 SIP Trunks + 100 DDIs + CLIP + 1Mb additional Etherflow bandwidth on existing spitfire Ethernet = £74 per month (Etherflow = Metro Band 2A). Existing 2Mb leased line @ £45 per month compared with Spitfire 2Mb Ethernet leased line from £180.00 per month.

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BUY ME

**The psychological tricks
that make us click**

How do online stores convince you to buy products that you really don't need? Barry Collins exposes the secrets of the online retail industry

We're all wise to the tricks that bricks-and-mortar stores use to tempt us to buy. Wafting the smell of freshly baked bread through the supermarket, knocking a penny off prices to make them appear a pound cheaper than they really are, and using bright lighting to make goods seem fresh and inviting. Less familiar, however, are the subtle – and sometimes not-so-subtle – techniques that are now used online to make us part with our credit card details.

Online stores deploy all manner of psychological triggers to ensure that you don't leave the site without putting a couple of items in your basket – the items that they want you to buy, that is, which might not necessarily be what you set out to purchase in the first place. The placement of buttons, the carefully selected reviews from fellow customers, the product photos, the colours of the action buttons and even the design of the “checkout” itself have all been tailored and tested to maximise the site's conversion rate – the proportion of site visitors who are “converted” into paying customers.

If you want to avoid being swayed by such tactics, you need to learn what to look for when browsing online stores. We've spoken to experts in online psychology and retail design to expose the methods used by leading online sellers. We've surveyed the sites of household names such as Amazon, Asos and EasyJet, to show you exactly how you're steered towards making a purchase. And we also reveal how to get your own back, by taking advantage of the retailers to get a better deal for yourself.

SOCIAL PROOF

Human beings are hugely affected by the opinions of their peers. As psychologist Graham Jones, author of *Clickology: What Works in Online Shopping and How Your Business can use Consumer Psychology to Succeed*, explained to *PC Pro*: “Part of the social glue that holds us together is that we like the things our friends like – it's the fuel that keeps the group going. It's a way of social groups reducing conflict.”

What this means in practice is that if we feel even a vague affinity with someone, we can't help placing a value on their preferences and decisions – even if we've never met them, or have zero proof that they actually exist. It is precisely this that Amazon and other retailers are banking on when they cram their homepage and product pages with boxes claiming “people like you also bought this”. According to Jones, “they're using the psychology of ‘social proof’ to get you to buy things that, actually, you may not even have considered buying. Now your brain is saying ‘well, I ought to have it, because people like me have it’.”

The degree to which retailers personalise their recommendations varies, but the pull is more powerful the more you feel you have in common with fellow purchasers. Stores may harvest personal data supplied at registration, along with your buying history, to highlight reviews from those with similar traits. You may even be offered discounts for filling out surveys, to give stores yet richer information on which to base their recommendations.

“It isn't only about having user reviews on there, but providing a point of identification,” said Emma Travis, a strategist at retail conversion-optimisation specialist PRWD. “If you could include the gender, the age, and the interests of the person doing the review, for example, that will help someone visiting your website to say ‘if it's suitable for them, it's suitable for me’.”

Sometimes sites combine social proof with another very powerful trick – appealing to people's egos. “LinkedIn does this very well,” said Nathalie Nahai, a digital strategist and author of *Webs of Influence: The Psychology of Online Persuasion*. “They might put up ‘20 things every exceptional boss should know’. Then they'll use a lead saying ‘good bosses do XYZ, exceptional bosses do more’. You've already bought into the idea of being a good boss, and of course you want to be exceptional, so you have to read on, and end up being sold to.”

The ultimate endorsement comes from those you know personally. For example, Google uses the homepage of the Play store to promote items that have been rated by your contacts, even going so far as to show you their photo alongside an image of the product itself. The store also encourages you to “follow” others in your social circles to “learn from people in the know”, increasing the authority and trust you place in the store itself.

This tactic might seem less manipulative than other methods of online selling, since you're being shown the genuine opinions of your friends. But don't for a second think that the items in question have been highlighted purely because they're popular. “They'll be selective in what they're pushing,” warned Jones. “The retailer will be choosing the items that are the most profitable for them to sell to you.”

At the opposite extreme, even the endorsements of entirely anonymous customers can encourage us to buy. Travis said that sites can see a huge upswing in sales simply by promoting a USP such as “nine out of ten of our customers” rate a product highly. “We've run an experiment with one of our clients, where they put a USP bar on their homepage with social proof in it,” she told us. “It actually increased the key conversion rate by 20%.”

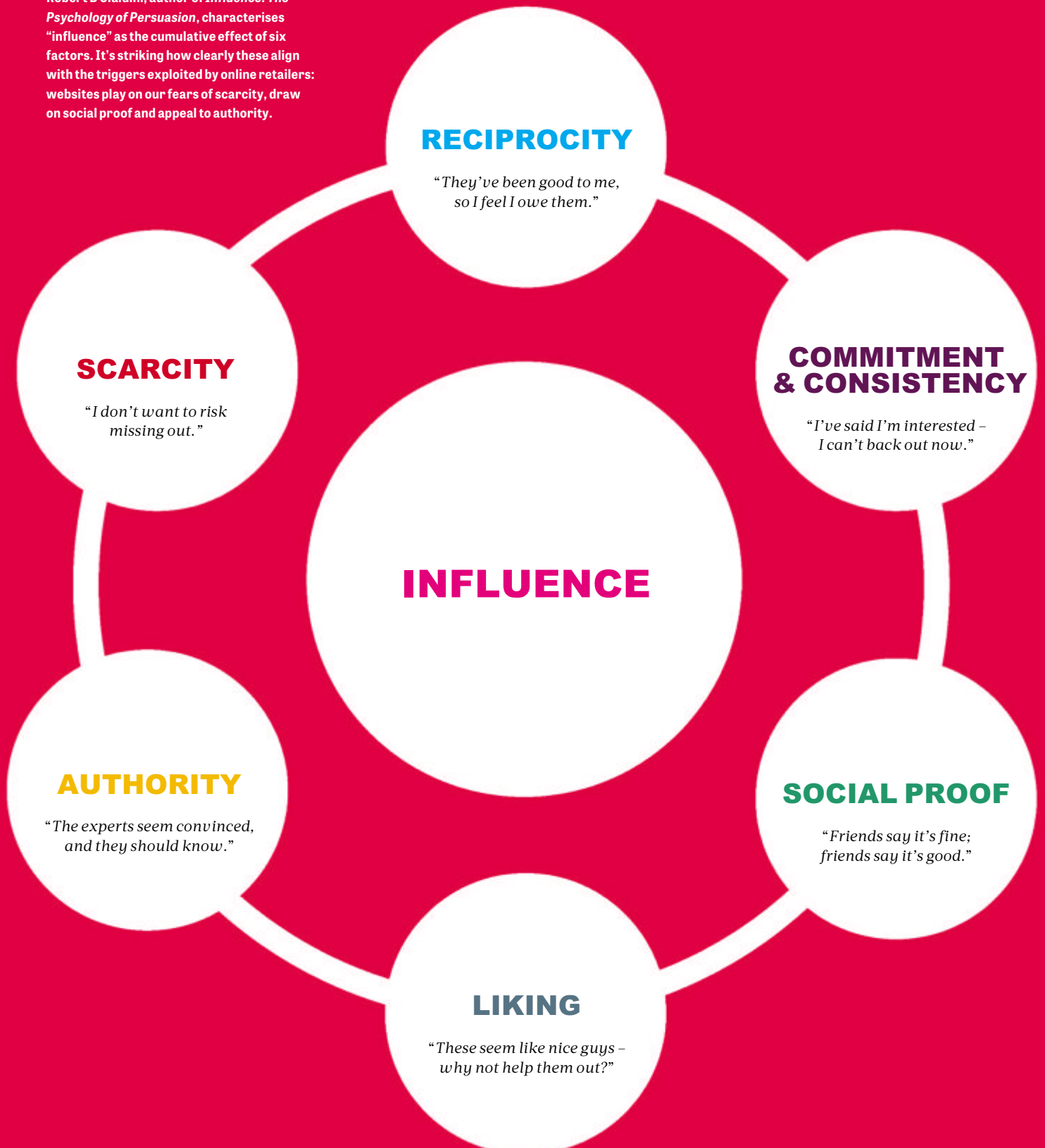
What about negative reviews? You might think that the presence of the odd one-star review proves that you're not being steered in a particular direction – but that's exactly what the retailers want you to think. “Having negative reviews is actually likely to increase trust, because it says

“If we feel even a vague affinity to someone, we can't help but place value on their preferences”



PSYCHOLOGY OF INFLUENCE

Robert B Cialdini, author of *Influence: The Psychology of Persuasion*, characterises “influence” as the cumulative effect of six factors. It’s striking how clearly these align with the triggers exploited by online retailers: websites play on our fears of scarcity, draw on social proof and appeal to authority.



‘we’re not perfect’,” Travis pointed out. If the negative review includes a response, that’s a further feather in their cap, because it shows the customer that the site cares about complaints.

PRICING TACTICS

Online retail is a highly price-sensitive business. Amazon has spiders constantly crawling other websites to check prices, and might change its own prices several times a day if better deals are detected elsewhere. However, setting prices isn’t merely about undercutting the competition: there are some crafty psychological tricks that can be deployed here too.

Most buyers have become wise to the age-old practice of knocking a penny off a round number, to make us perceive the price as lower. But taking off a few more pence can be enough to give this trick a second wind. “Online, you’ll see lots of prices ending in seven,” said Jones. “When you sell at £9.99, you don’t sell quite as many as you do at £9.97. It appears that the extra couple of pence makes people think it’s cheaper.”

This isn’t the only exploitable trick our brains play on us. “There’s evidence to suggest that the longer it takes to say the words in the price, the more expensive we think it is,” revealed Jones. “On television, those adverts for the latest sales at DFS won’t say this is ‘six-hundred and ninety-nine pounds’ – they’ll say this is ‘six-nine-nine’. Retailers will all be looking for ways to reduce the number of syllables in a price, because when we read it, we hear it in our heads. We need to ‘hear’ those prices in as short a time as possible.”

The same principle can be used to put a more effective spin on sale offers, according to Nahai. Our brain processes numbers more quickly than it does words, so websites will generally do best when advertising goods as “50% off” rather than “half price”, “two for the price of one” or “buy one get one free”. It simply takes our brain longer to process the words – and, as we all know, the internet reduces our attention span to that of a toddler in a toy shop.

Even the ordering of the numbers in a price can affect our perception of value, according to Jones. Numbers presented in descending order appear cheaper than those that ascend. “If you have something at £567, we perceive that as considerably more expensive than £543,” said Jones, even though the proportional difference is small.

Tricks such as this can be used in a targeted way to push us towards choosing certain products. Given the choice between, say, two televisions on a website, most people will gravitate towards the cheapest. But if three options are presented “the one you actually want people to buy ends up as the middle option,” observed Travis. It works for the same reason that an inexperienced wine buyer might choose an £8 bottle of plonk: they don’t want to pay for the most expensive option, but they don’t want to take a gamble on the cheapest either. By choosing which products to offer, the retailer can calibrate visitors’ perceptions of value and steer them in the desired direction.

While all of these tactics take advantage of broad psychological tendencies, retailers also use experimental methods to find out the specifics of what pushes our buttons. For services such as online storage or software, where you might get “basic”, “pro” or “enterprise” accounts, the differences between tiers are often presented in the form of a ticklist of features. Sites may experiment with different variations of the offer, to work out which features customers are most willing to pay for. Travis revealed how one client tested eight variations of a feature table on its site, and found that the winning variant produced an 185% uplift in conversions. “There was no way we could have worked out through psychology alone which of those benefits would have triggered those

“The longer it takes to say the words of a price, the more expensive we think it is”

HOW AMAZON KNOWS WHAT YOU WANT BEFORE YOU’VE EVEN ORDERED IT

Customer data can be an incredibly powerful tool for online stores seeking to maximise sales. Amazon is now so confident in its ability to predict customer behaviour from data that it’s filed a patent for delivering items to customers before they’ve even ordered them.

Dubbed “Speculative Shipping”, the idea is to minimise the frustration of postage delays and reduce the amount of time stock spends sitting in Amazon’s warehouses. Let’s say, for example, that you’ve pre-ordered the past three Call of Duty games from Amazon. Based on that history, the company can make a good guess that you’re likely to be interested in the next episode, and which

console you’ll want it for. If you’ve looked at the page for the forthcoming release six times in the past fortnight, that’s probably a significant sign too. It all points towards the conclusion that if a chap arrives at your door at eight o’clock on the morning of release with a cardboard package in his hand, you’ll gladly take it.

In practice, Amazon may not go as far as actually delivering a £50 game on an educated hunch. The patent also describes scenarios in which such data is used to estimate demand for a product in a given area. If Amazon calculates that 30 people in your town are likely to order a best-selling DVD in the week before

Christmas, it can have them ready at a local distribution centre for next-day – or even same-day – delivery.

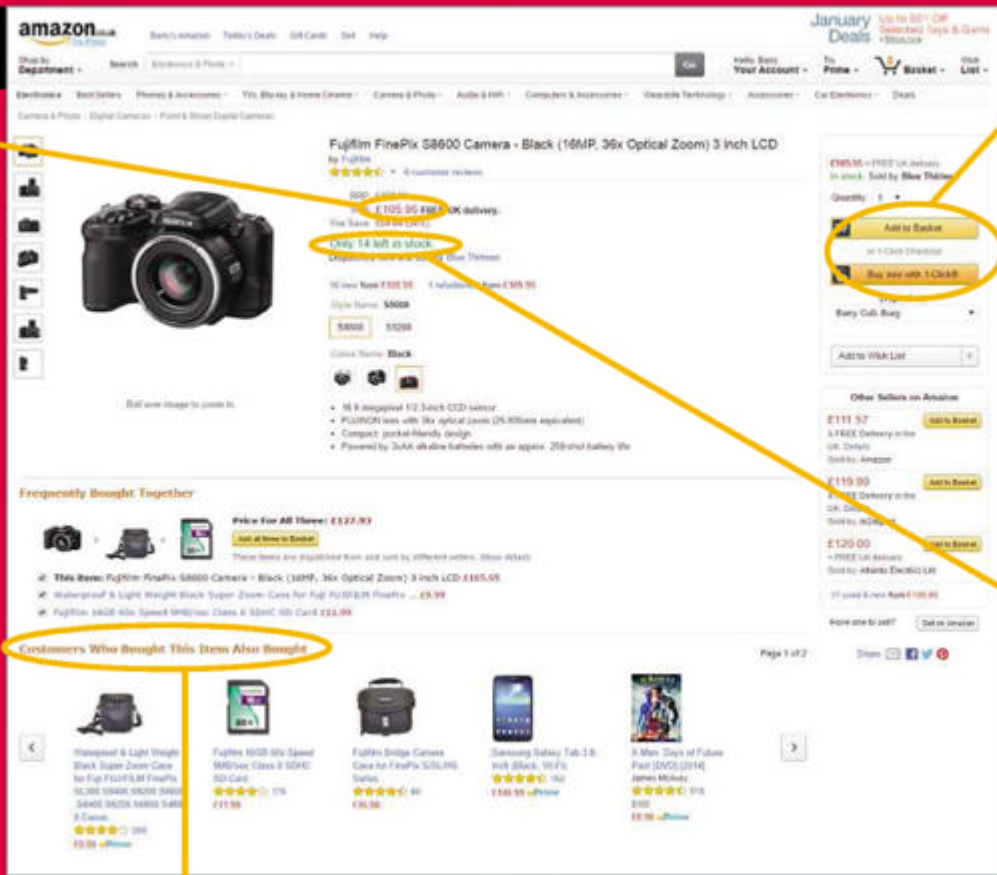
What if Amazon speculatively sends you something you don’t want? Amazon’s patent lays out several scenarios for enticing customers to take the goods, including the possibility of offering discounts while the package is in transit. Alternatively, “if a given customer is particularly valued (according to past ordering history, appealing demographic profile, and so on) delivering the package to the given customer as a promotional gift may be used to build goodwill”. In other words, it’s on the house!



AMAZON

Shoppers are wise to the trick of ending prices in .99 to make them appear a pound cheaper than they really are. But knocking off only a few more pence can still make the item appear more of a bargain.

The English language reads from the left (the past) to the right (the future). Amazon places its buying buttons at the right because that's what it wants you to do next.



Amazon uses social proof – the opinions of “people like you” – to try to sell you more products, even items (such as the tablet and the DVD) that are completely unrelated to the item you’re currently considering purchasing.

The “FINAL REDUCTIONS” offer, highlighted in a colour that contrasts starkly with the rest of the site, draws the shopper’s eye and underlines the sense of value.

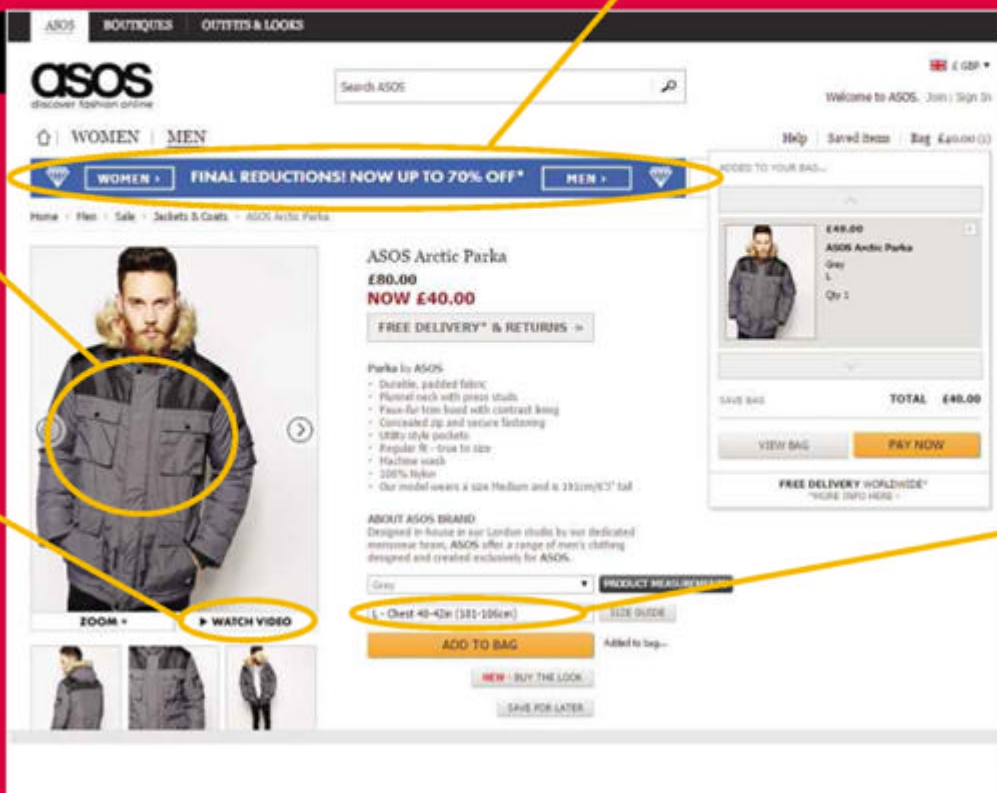
Shoppers, especially men, are attracted to the colour red – a “potent sexual signal” in nature, according to psychologist Graham Jones. Amazon’s “Add to Basket” button is a yellow/orange colour, but the button they really want you to press, “Buy Now”, is closer to red.

Many online retailers play on the fear of scarcity. By revealing that it has only a limited stock of an item, Amazon is tapping into the basic human desire not to go hungry.

ASOS

Each of the four photos of the jacket is zoomable, allowing customers to see the texture of the fabric close-up, getting as close to the store shopping experience as possible.

Asos provides a catwalk video for every garment it sells. “Shopping is a visual medium,” said Nathalie Nahai. The video “increases familiarity and the sense of trust” in the product.



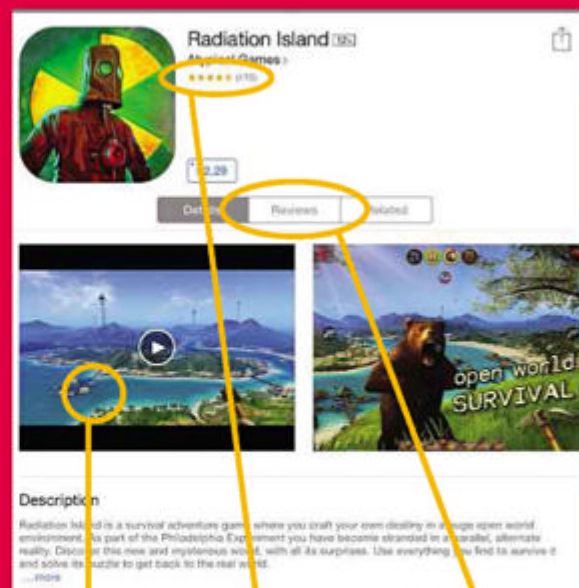
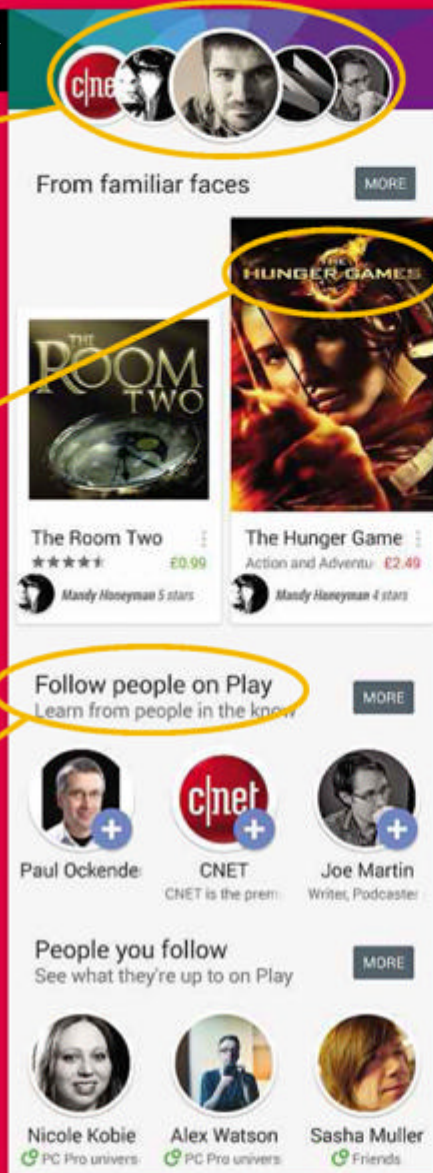
The website also allows you to enter the measurements of your existing clothes, so you can see how the fit will compare with the item you’re thinking about buying. Again, it’s about increasing trust in the purchase, as well as helping to reduce the crippling returns rates suffered by many clothes retailers.

GOOGLE PLAY

The Google Play homepage plays strongly on the influence of your peers, picturing you at the centre of your friends and associates, and displaying their personalised recommendations below.

The ultimate social proof comes from a known associate. Note that the more expensive of the two recommendations has its price in red, while the cheaper item is priced in green – red being the colour that the male eye is drawn to immediately.

Emma Travis from retail consultant PRWD told us that there are three key factors influencing buying decisions: personalisation, emotion and trust. Offering recommendations from friends provides personalisation; the “learn from people in the know” line is designed to assert authority and foster trust.



APPLE

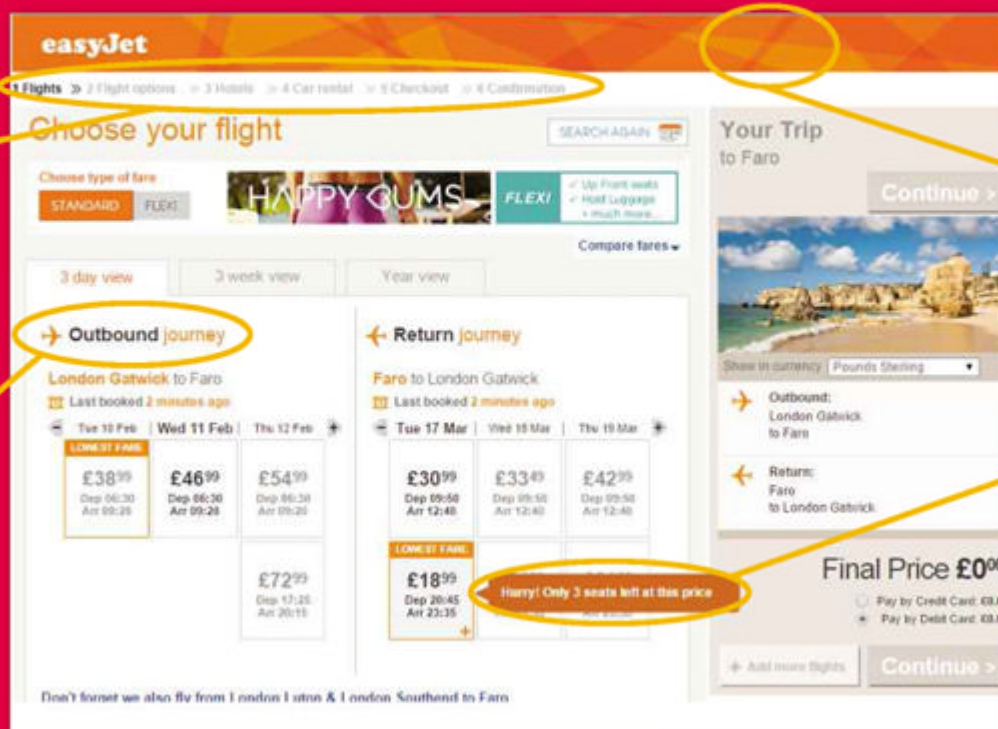
Introduced relatively recently to the App Store, the video previews are another potent sales tool. In the same way catwalk videos help people to imagine what clothes would look like on them, the videos help potential buyers get a better feel for the game.

Apple makes heavy use of social proof in the App Store charts. Not only are these apps already popular with other iPad owners by definition, but each has a star rating attached to reinforce the recommendation. Once selected, the app's rating is also featured prominently.

You can't see it here, but the Reviews tab hammers home the social proof, this time inviting you to “be the first of your friends to like this” on Facebook at the very top of the page. Not only is it playing on your desire to seem ahead of the curve, it's relying on the strongest recommendation of all – friends and family – to sell more copies of the app.

EasyJet breaks down the booking process into several small steps rather than one long form. This makes it seem less laborious than it really is, and provides a sense of progress.

The price of the desired journey is presented between a cheaper and more expensive option. People will often choose the one in the middle because their perception of value has been anchored by the cheaper and more expensive items.



EASYJET

Orange is EasyJet's corporate colour and one that has become associated with “cheapness”, according to web psychologist Nathalie Nahai.

EasyJet is cranking up the fear of missing out, urging buyers to “hurry” even though there will almost certainly be more seats available for similar prices.

customers,” she said. “But through testing, through actually laying those things out in a table, we were able to see which one tipped them over.”

SCARCITY SCARE TACTICS

If you’ve seen the “Black Friday” footage of grown adults scrapping in supermarkets to get their hands on the last of the cheap televisions, you’ll appreciate that scarcity is a powerful trigger – and it’s one that online retailers routinely exploit.

The little “only six left in stock” label Amazon often puts on items, or the “Hurry! Only four seats left at this price” alerts that pop up over EasyJet flight options, are designed to stimulate one of our base human instincts. “It taps into a fairly basic survival instinct in our brain,” says Graham Jones. “If we go back through our evolution, we were much more interested in food when it was scarce than when it was plentiful. People don’t like scarcity. They fear they’re going to miss out.”

Budget airlines play on this fear particularly aggressively: they tell you not only how few seats are available at a given price, but also how many other customers are searching for that flight at the same time (the truthfulness of those figures only they know, of course). Some even use cookies to put the price up should you return to search for the same flight a day later. In this way, even if they don’t get your custom this time, they train you not to delay the next time you come looking for cheap flights.

Legally, online retailers aren’t allowed to lie to customers about the remaining stock of a particular item, but there are ways to get around the rules: “Only five left at this price” is a common tactic, before the item is then instantly restocked at a marginally different price. Voucher codes for certain products that end on a specific date are another means of creating artificial scarcity: nobody wants to miss out on a bargain.

SITE LAYOUT & COLOURS

The psychology of online retail doesn’t rely solely on deep-seated emotional triggers. It can also employ much more straightforward tactics, such as simply laying out the site in a way that encourages engagement.

Jones explained that, just as you know that baked beans are in the second aisle of your local branch of Tesco, online shoppers expect the layout of a retail website to be instantly familiar.

“Most people do most of their shopping with the big retailers: Amazon, Tesco and so forth,” he said. “All of those big online retailers will have their shopping cart’s checkout button at the top right, and their search bar in the top middle. If you’re a retailer that doesn’t have your shopping cart on the top right, or your search bar top middle, then people won’t know how

“Scarcity is a very powerful trigger, and one that retailers routinely exploit”

HOW TO GET YOUR OWN BACK

Retailers may use tricks to encourage you to buy, but there are ways you can play them at their own game

DEMAND THE DIFFERENCE IF THE PRICE DROPS

Retailers such as Amazon might fiddle with the price of a product several times a day to ensure they’re never undercut by rivals. This means you can miss out on a discount in the time it takes for the product to be shipped, especially on expensive electronics. Remember that the Distance Selling Regulations generally give you a 14-day cooling-off period to return goods bought from any online store, and Amazon in particular gives you 30 days to return unused items. Use this to your advantage: contact customer services and threaten to return the goods unless they refund the difference between what you paid and the new price. There’s a good chance the retailer will acquiesce, because they don’t want the hassle and expense of handling returns.

DON’T TRUST SITE SEARCH ENGINES

If you want to find a specific product on a retail site, don’t use the site’s own search engine. An expert who wishes to remain unnamed told us that some sites remove special offers or discounts from products when the customer searches specifically for them, on the basis that those customers are already interested in the product and therefore don’t need extra encouragement. You may get a better deal by searching the site through Google or another search engine.

LET ITEMS LANGUISH IN YOUR CART

Since so many online purchases are abandoned at the shopping cart, retailers will sometimes offer you an extra incentive to close the deal. If you’re in no hurry, try adding an item to your basket, then waiting a couple of days before checking out. The store may email you a reminder that the item is still in your basket – often with a discount voucher to encourage you to complete the transaction.

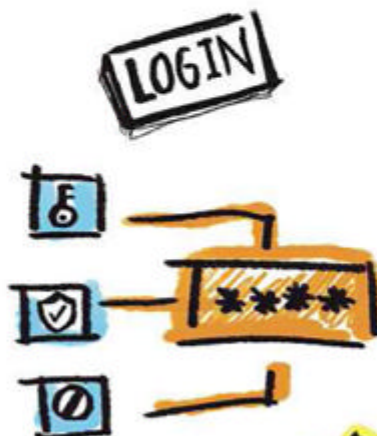
RUN YOUR OWN AMAZON PRICE TRACKER

It would be a full-time job to try to keep track of all the prices on Amazon, but there are tools available that can do it for you. The uk.camelcamelcamel.com website can send you alerts via Twitter or email if a price of a selected item drops below a certain threshold. Or, if you have several items on your Amazon wishlist, you can create an unofficial price-tracking spreadsheet in Google Docs to get a daily email alert if a price changes. The template is available to download at pcpro.link/247pricetracker.

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to use your website. Many retailers lose out on sales because they're not doing what the big companies do."

That particular template hasn't become dominant by chance. "Here [in the Western world], where we read left to right, our brain sees the left-hand side as the past and the right-hand side as the future," explained Jones. "So if you want people to buy something, you're better off putting your 'Buy Now' button on the right-hand side of the page."

Believe it or not, the colour of that button is also critical. Jones cited research showing that red "Buy Now" buttons achieve better clickthrough rates than other colours, especially on sites targeted at men. "The reason is that red is a potent sexual signal," he claims, pointing to examples such as red lipstick and, further down the evolutionary chain, baboons' backsides. "Men are wired to be interested in things that are red." Red is less of a turn-on for women, which is why sites that appeal to a mixed audience (such as Amazon and Asos) use a more neutral orange colour for their buying buttons. It still has that reddish hue to appeal to the male shoppers, without putting off women.

Jones noted that many retailers make the mistake of using green buying buttons, because of the colour's association with "Go". Independently, though, two of our experts cited research indicating that green "Buy Now" buttons are less effective than red ones. "You can be quite relaxed about whether or not you obey the green traffic light," reasoned Jones. "You can't be relaxed about obeying the red one."

When it comes to more general use of colour, it seems there's no solid research establishing whether (for example) a blue site will in general perform better than a white one. However, there are certain colours that come preloaded with connotations – such as EasyJet's cleverly chosen orange branding. "In most western European countries, the colour orange is associated with cheapness," said Nahai, "and in the Netherlands, it's the national colour, so orange is seen as very positive."

THE POWER OF PHOTOGRAPHY

On the high street, shopping is a tactile experience: we brush our fingers over clothing, pick up objects and flick through books. Online shopping obviously lacks that first-hand dimension, so the most successful online stores bend over backwards to make shoppers feel as close to the products as possible. Amazon's Look Inside feature, for example, replicates that real-world experience of flicking through a paperback in a bookshop, checking out the size of the print and taking in whatever odd phrases and illustrations may catch the eye. One of the most successful ways of simulating real-world shopping is by providing lots of

high-resolution photos for would-be customers to pore over, so that they can zoom in and see the weave of that fabric, the texture on the laptop lid, or the grain on that coffee table.

"Product photography is about engaging the customer, replicating the product as if it were in their hands," said Emma Travis. "One of our clients, Schuh, is particularly good at this. They take about eight photos per shoe, including the sole. This may sound silly, but it's something that comes up quite a lot – people want to know the tread of a shoe, if it has good grip, whether it's coloured. That kind of stuff really does help."

Asos's sales shot up by 20% after it introduced catwalk videos of models wearing garments, according to Nahai, because "people could imagine how it would look on themselves". The Fits.me software – used by sites such as T M Lewin, Thomas Pink and Austin Reed – goes further, allowing shoppers to enter their vital statistics and see exactly how a selected garment would fit them. The software removes the inconvenience and potential embarrassment of going to the shop to try stuff on – and the company claims it's cut size-related returns by 77%.

SEALING THE DEAL

Even after a retailer has persuaded you to fill up your shopping basket, the battle isn't won. The Baymard Institute, which provides analytics for e-commerce sites, claims that almost seven out of ten items added to an online basket are never paid for. Retailers therefore need to do everything they can to get you to complete your purchase.

One way in which they do this is to borrow a trick from theme parks. Just as Disneyland doesn't let you see the full length of the queue for a ride, the sharper online stores break up their checkout procedures into four or five shorter sections, so that you aren't put off by a lengthy looking form to fill in. Travis labels this the "momentum effect". "It creates the illusion of progress, because people feel like they're getting somewhere, that they've finished one page and are moving on to the next," she explained. Between them, those four or five pages might have exactly the same number of fields to fill in as a site with one long page, but because the next ten questions are hidden, you aren't discouraged by seeing how far you are from the end of the process.

Another way online stores seek to minimise abandoned purchases is through constant reassurance as the customer makes their way through the checkout process. A progress bar telling a customer they have reached, say, stage three of five gives them a sense of achievement, almost turning the checkout into a mini-game that the customer wants to complete.

"Another thing we've found to be very effective at increasing completion rates is, each time someone fills in a field – say their name, address or whatever – you add a green tick once they've finished it," said Nahai. "That's a very simple, subtle hack that gives people a sense of being rewarded."

It seems you really are very easy to please. And now you've completed this feature. Well done. ●

"Product photos are about replicating a product as if it were in your hands"

"Red 'Buy Now' buttons achieve better clickthrough rates than other colours"

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THE GREAT EASTER EGG HUNT

Even the most po-faced software products may contain an in-joke, game or moment of madness. **Stuart Turton** seeks out software's sillier side

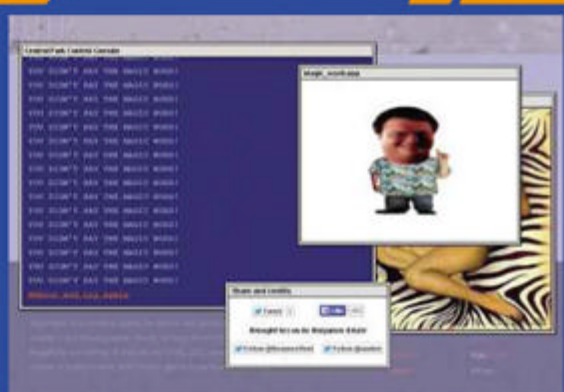
In 1979, Warren Robinett snuck a secret message to fans in his Atari video game, *Adventure*. Players were soon scurrying through every corner of the game world to locate Robinett's hidden message, the staff at Atari likening the madness to an Easter egg hunt. The term held, as did the practice, with jokes, snide references and strange commands ending up tucked away into thousands of products. Join us as we explore the strange corners of the software you use every day.

ZOMBIE ANDROID

The different versions of Android have always been named after tasty treats, including Gingerbread, Ice Cream Sandwich, Jelly Bean, KitKat and, most recently, Lollipop. Each of these has come with its own Easter egg, accessed by entering Settings | About Phone (or Tablet) and then repeatedly clicking on the Version tab until the magic happens. The subsequent animations have run the gamut from surreal to downright disturbing, although a *PC Pro* favourite has to be Gingerbread, which brought up a painting of the Android logo holding hands with a gingerbread man, while surrounded by zombies on smartphones.

404

404 is the error code you receive when a web page is down, or you've typed an address wrong. In most cases, such errors are irritating, but a few companies have made their 404s so good that we'd happily set the North Koreans on them, allegedly, just to see the messages more often. Our favourite can be found at nouveller.com/404 - which recreates the famous sequence from *Jurassic Park*, where tubby hacker Dennis Nedry lets the dinos loose. Don't forget to enter the magic word. A close second is the 404 for the NPR website (pcpro.link/247notfound), which simply lists other missing things, from Atlantis to Wally, to your luggage.



ABOVE Fans of *Jurassic Park* don't need us to explain what inspired this brilliant 404 error page...

LINUX FREES THE FISH

Linux is the work of a million mad geniuses, which means Easter eggs are stuffed into every coded crevice. Start messing about in the terminal and jokes tumble out like clowns spilling free of an exploding car. Start with Alt+F2, and then type "free the fish" to release Wanda the goldfish onto the desktop. Aside from being a rather jolly presence, Wanda also dispenses snippets of fortune-cookie wisdom such as "You are confused; but this is your normal state". Equally wonderful are the various calendars, accessible through the terminal by typing "ls/usr/share/calendar/". Among our favourites is the *Lord of the Rings* calendar, which marks the progress of the ring-bearer and his pals as they travel halfway around the world to stop Sauron getting married. Disclaimer: we may have taken the wrong message from that book.



LEFT Not only will Linux free your fish, it can also dispense helpful advice about your state of mind



SILLY OLD SKYPE

Not all of Skype's emoticons can be found behind that sinister, ever-smiling face to the right of the instant-messaging box. Typing commands such as (moon), (drunk), (swear), (smoking) and (poolparty) can bring a great deal more... colour to your conversations.

GEEKS R GOOGLE

One day, Google employees will be just brains in jars, wired directly to the internet, so we should all enjoy their capacity to feel human emotion while we can. As the delivery service for popular culture, it's no surprise to see Google's gaze encompass perhaps the geekiest of all sci-fi shows, *Doctor Who*. Head to Earls Court in Google Maps (pcpro.link/247tardis) and you'll notice a police box sitting outside the Tube station. Hit the white "X" that appears in front of it and you'll be ushered into the Tardis.

Speaking of things that are rarely right side up, searching for "askew" will knock the page sideways, while typing "do a barrel roll" spins the page 360 degrees – a feature worth trying out on a colleague who's looking the worse for wear. Should that fail, type "zerg rush" – a term borrowed from Blizzard's *StarCraft* video game – which invites a swarm of zeroes onto the screen to start devouring your search results. Click the zeroes to score points.

But this is just the start, with hundreds of Easter eggs tucked away in Google products. Indeed, Wikipedia has a curated list of the best (pcpro.link/247google), many of which have a hint of melancholy. Search for "loneliest number", for instance. Perhaps Googlers sense their time in the jar is coming.

BELOW *Doctor Who* fans can step back in time to visit the Tardis circa 2012, simply by heading to Earls Court in Google Maps



APPLE BITES

Whereas Google's Easter eggs revel in popular culture, Apple's Easter eggs revel in Apple culture – a fact that will surprise nobody. For example, the icon for the TextEdit application is a pen and notepad with something written on it. If you pull up the icon in Finder, you'll discover it's the "Here's to the crazy ones" speech narrated by Richard Dreyfuss in Apple's 1997 ad campaign, which subtly suggested that if Albert Einstein and Gandhi had been alive they'd have used Macs, and possibly worn black polo necks, and probably worked in Apple's marketing department.

Among the user-avatar icons is a picture of a record with the words "magic, revolution, boom" and "unbelievable" printed on it. These were the words Steve Jobs used most frequently during keynote addresses, and probably while making omelettes at home: "I'm just adding a little cheese to the top, BOOM, unbelievable. Look at how crisp that is, isn't it beautiful? I've revolutionised the omelette."

He'd usually go on to sledge Microsoft, so thankfully there's a little tribute to that in OS X as well. If your Mac discovers a PC on the shared network, it will display a 1990s-looking computer with Microsoft's "Blue Screen of Death" error message on the display. Thankfully, Apple found the ideal expression of this curt, clipped superiority in Siri, its personal assistant. Say "OK Glass" to Siri – the command for launching Google Glass – and you'll receive one of six irate responses, including "Very funny. I mean, not funny 'ha-ha', but funny", "I think that Glass is half-empty", "Stop trying to strap me to your forehead. It won't work", and "Just so you know, I don't do anything when you blink at me."

If you're not in the mood to hear what Siri's thinking, head to the Terminal in OS X, type "emacs" and hit Enter, then press Esc+X. Then enter "psychoanalyze-pinhead" and watch as your Mac turns its Freudian gaze upon itself.

WHO UPSET MOZILLA?

Firefox is the little browser that could, then did, and then couldn't work out what to do next. Built as the anti-Internet Explorer, it championed openness, speed and not being rubbish, and set the standard for all of those things until Chrome came along and stuck a massive multicoloured flag in the internet.

The history of this struggle is told through a sinister Easter egg buried within the browser. Type "about:about" into the address bar and select "about:mozilla". You'll be presented with the phrase "Mammon slept. And the beast reborn spread over the earth and its numbers grew legion. And they proclaimed the times and sacrificed crops unto the fire, with the cunning of foxes. And they built a new world in their own image as promised by the sacred words, and spoke of the beast with their children. Mammon awoke, and lo! It was naught but a follower. From The Book of Mozilla, 11:9."

Although it sounds like something you'd find scrawled on the wall of a serial killer's shed, the page reference refers to an important milestone in the company's history, with the quotes updated whenever there's a new release. After you've fled the "about:mozilla" page, stop by the "about:robots" page for a crash course in geeky robot references.

ADOBE ATTACKS

Think Adobe and you're quite likely to think industry-behemoth-that-has-come-to-take-over-the-world, so it's perhaps surprising to learn that behind that serious façade lies a jolly heart, expressed in half a dozen genuinely amusing Easter eggs. Among them is InDesign's friendly alien, who will turn up if you wade into the File menu, select Print Presets and click "Define...". Create a new Print Preset and call it "Friendly Alien", then save it. Now open a blank document and go to File | Print, and change the print preset at the top of the dialog box to Friendly Alien. Click the large P in the Print Preview window in the dialog box. You'll receive a visit from the alien, whose smiling face should be enough to dispel the despair instilled by InDesign's print options. If that's not helping to lift your mood, pop over to Muse, and place an Anchor on the design canvas. Copy and paste this a snowman character (available from the Muse Facebook page at pcpro.link/247snow) into the anchor name and it will start snowing.

TERMINAL STRIKES BACK

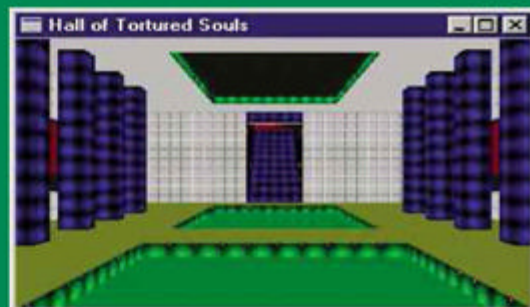
Ever thought the problem with *Star Wars* was the special effects, actors, colours, movement, sound effects and, you know, visual elements? Well head over to the terminal in Linux or OS X, type in "telnet towel.blinkenlights.nl" and hit Enter.

Witness the glory that is *Star Wars* in ASCII art. Windows owners can enjoy this foolishness, too, but if you're running Windows 7 or later, it will require a little fiddling to get going.

The internet is your friend on this one.



RIGHT It's a shame Microsoft has stopped creating Easter eggs, because some of them were instant classics – such as this Doom-like game hidden in Excel 95



ESCAPE FROM MICROSOFT

If a psychiatrist had examined the Easter eggs in Microsoft's products throughout the 1990s, they'd have stormed Redmond and demanded Bill Gates release the programmers he surely had chained up in the basement. Each one is a little cry for help, none more so than the "Hall of Tortured Souls" in Excel 95. This Doom-like mini-game dropped players into a maze decorated with the names and faces of the Excel team. Thankfully, the graphics of the day couldn't convey the screaming, visceral horror of their imprisonment, so instead we got a maze designed by demented Teletubbies. Excel 97 swapped out the inescapable maze for a flight simulator (a cry for freedom if ever we heard it), and then a racing game in Excel 2000 (help us, we're going nowhere fast). These quiet pleas by the programmers were snuffed out in 2002, when Microsoft launched its Trustworthy Computing initiative, which promised nothing unexpected would find its way into your software – except for bugs, disappointment, bad ideas and sudden U-turns. Good to know where we all stand.



YOUR CHAIR

Evidence suggests that sitting down all day makes you unproductive and unhealthy. **Joel Snape**, acting editor of *Men's Fitness*, helps you introduce movement to your day

Are you sitting comfortably? Then you should probably get up and walk around a bit. Scare stories that draw a parallel between the ill effects of sitting and smoking may be overstating the case a little, but not by as much as you'd think. After all, while you can give up tobacco, it's a lot tougher to renounce your workstation or find the e-cigarette equivalent of a chaise longue. Since most modern jobs involve hours of sitting down, the obvious questions are: what's causing the damage? And what can you do about it?

One problem is what researchers call non-exercise activity thermogenesis (NEAT).

The more you sit, the lower your NEAT, the fewer calories you burn: 1.36 calories per minute fewer, according to studies.

According to Dr James Levine, author of *Get up!: Why Your Chair is Killing You and What You Can Do About It*, low NEAT is linked to weight gain, diabetes, heart attacks and cancer, and standing up for even a few extra hours a day can make a difference.

Exercise can help with the calorie expenditure part, of course, but an hour or so a day isn't enough. Why? Put simply, because sitting down puts your body on standby. When you do this for any length of time, your circulation becomes constricted,

your metabolism slows, and your connective tissues tighten.

"This causes your hip flexors – the muscles on the front of your thighs – and your hamstrings to contract or shorten," says Dr John Tanner, a musculoskeletal expert and osteopath. "Your buttock muscles are also constantly stretched with your knees at a 90-degree angle, which leads to muscles and joints tightening so much that your body moves less freely, decreasing agility and making you more prone to injury."

All this results in placing stress on your lumbar spine, leading to lower-back pain that's responsible for an estimated 4.5 million days off work in Britain each year.

Sitting for extended periods has also been linked to increased waist size and risk of a host of cardiovascular diseases, even among otherwise active individuals. The problem, it seems, is "uninterrupted sedentary time".

6'0"

5'6"

5'0"

4'6"

4'0"

3'6"

3'0"



SKILLING YOU

FIGHT BACK

And as if spending nine hours a day sitting in a chair weren't bad enough, PC slouch is arguably even worse – whether you're tapping numbers into Excel or playing Eve Online, working at a desk exacerbates the tendency to round your shoulders forward, squint and tense your facial muscles.

Movie-goers' knee – the chronic joint pain that comes from prolonged contact between the femur and patella (whether it comes from sitting in a multiplex or at home) – is also a recognised medical problem, and even an hour of sitting down can make your back measurably tighter, as it tries to compensate for everything else.

So what's the solution? Exercise alone, as mentioned earlier, won't cut it. Yes, it helps with the NEAT part, reduces your chances of obesity-related problems and has protective effects against everything from osteoporosis to Alzheimer's – but it won't fix the mobility issues or long-term effects of sedentary times.

For those of you under the impression that swapping that chair out for an exercise ball will solve these issues, think again. Studies show that muscular activation is largely the same whether you're sitting on a ball or a chair, and the greater contact area can actually lead to more soft-tissue compression and spinal shrinkage, as well

as more stiffening in the upper back and neck.

Studies of kneeling chairs, meanwhile, remain inconclusive; they tend to focus on postural comparisons rather than muscle activation, so it's difficult to draw any firm conclusions. One key comparison suggested that the lower body "switches off" in kneeling chairs, which may make them worse than a well-designed office chair.

Of more benefit would be to stand up. At least one study suggests that computer users who stand up for an hour during their workday have less back pain. Standing up has also been linked to reduced risk of cardiovascular disease and can help regulate your body's glucose supplies, which helps

"SITTING FOR EXTENDED PERIODS HAS BEEN LINKED TO INCREASED WAIST SIZE AND CARDIOVASCULAR DISEASE"



HOW TO KICK THE SITTING HABIT

SET A TIMER

According to research conducted by *The New York Times* correspondent Gretchen Reynolds, "new science shows very persuasively that standing up about every 20 minutes, even for only a minute or two, reduces your risk of developing diabetes and heart disease." You don't need to do star jumps or anything ridiculous – just go and get a glass of water.

WALK AND TALK This isn't only for the West Wing. Dozens of companies now have walk-and-talk – or at the very least stand-and-talk – meetings. If your place of work is unconvinced, point out that successful companies such as HR mega-firm Salo have their own walking tracks, or that top telesales people stand to make calls because it makes them more dynamic and creative.

GET A STANDING DESK Decent ones start in the £300 range – not too much of a stretch if you can make the case that it will make you more productive. Introduce standing-time slowly; maybe do it while you check emails, or do other non-creative but necessary tasks. Need to "blue sky" a solution or multitask? Feel free to slump in your chair.

TRACK YOUR ACTIVITY Almost any fitness tracker – and a slew of phone apps – will count the steps you take every day, and a host of studies suggest that 10,000 is the magic number for a variety of health benefits. Having metrics to improve on can help, especially if you're able to plan meetings across a variety of locations, or just get away from your desk for ten minutes at a time.

THE ANTI-CHAIR WORKOUT

Don't get up – you can fend off some of the worst effects of sitting while still deskbound, if you take some advice from MobilityWOD founder Kelly Starrett

INTERNAL HIP ROTATION

Cross one shin over the other thigh and try to pull that leg across your body, while leaving your other foot flat on the floor.



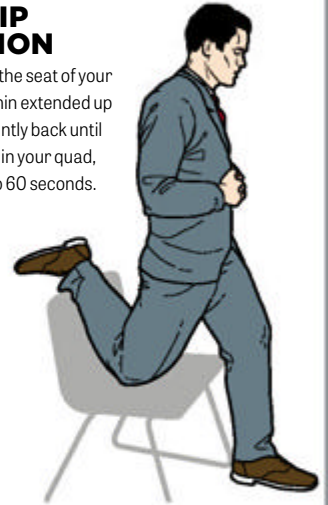
SEATED HIP FLEXION

Rest your right foot on your left thigh to make a seated figure-four. Next, keeping your back straight, bend forward at the hips, feeling the stretch in your hip.



CHAIR HIP EXTENSION

Put your knee on the seat of your chair with your shin extended up the back. Lean gently back until you feel a stretch in your quad, and hold for 30 to 60 seconds.



THE TWO-MINUTE POSTURE FIX

It isn't only your legs that need to move. Counteract the office slump with this three-move workout, created by trainer Jessica Wolny (jessicawolny.com)

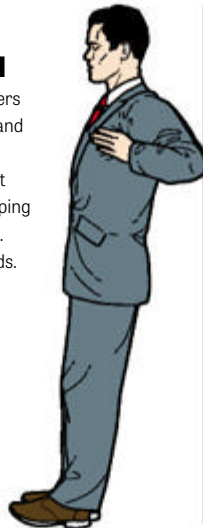
BATWING

Standing roughly 30cm from a wall, lean back against it, bracing yourself so that your body is straight. Now, keeping your thumbs in your armpits, push yourself away from the wall using your elbows, and hold for 10 to 15 seconds. Repeat a total of three times.



CHEST STRETCH

Interlink your fingers behind your back and raise your arms, pushing your chest forward while keeping your back straight. Hold for 30 seconds.



S-REACH

Try to link your arms together behind your back – one up, one down. If you can't reach, use a small towel or something similar to hold the stretch. Do this for 30 seconds on each side.



Images: Peter Liddiard

you use up energy from food more efficiently and can lower your risk of type 2 diabetes. There's even evidence standing can reduce the risk of developing certain types of cancers.

But there's another issue to consider: how much work you actually get done. Standing up or even strolling around might be fine if your job isn't all that cognitively challenging – or if you're just “researching” on Reddit, for instance – but how does it work if you're involved in intricate decision-making?

In general, research suggests little difference between sitting and standing. The exception comes in cases of more complicated multitasking, where sitting is apparently better. Walking is a different matter entirely: study participants invariably end up stopping when they need to work on complex tasks. In both cases, however, researchers noted that there's a chance that performance would improve with time and experience.

A better option is to move around in between bouts of work. Those who regularly

“THOSE WHO REGULARLY STAND THROUGHOUT THE DAY REPORT THAT IT MAKES THEM FEEL MORE ENERGETIC”

stand throughout the day report that it makes them feel more energetic, while research suggests that cognitive performance increases in those who make exercise part of their daily routine. This isn't restricted to middle management – a slew of writers, from Ernest Hemingway to Vladimir Nabokov, did most of their work while standing. American novelist Philip Roth once claimed to walk half a mile for every page he wrote.

So, assuming you're not a Pulitzer-prize-winning novelist, how can you get more

standing into your life? Going straight from endless sitting to non-stop standing isn't recommended – it will feel like torment, and isn't likely to be good for your productivity. Small, incremental changes are key: just moving from your desk to the office kitchen a bit more at first, taking phone calls while standing up, or even instituting walking meetings can help.

Another solution is to invest in an adjustable-height desk; converts swear by them. Expensive versions come with an electric motor, while cheaper units offer adjustments via hand-crank. Most experts recommend starting out with a 1:1 sit/stand ratio, adjusted as you get used to the new experience – you can do it by task, or time.

To get started, refer to the short exercises above. None of them involve having to change into fitness clothing or getting sweaty. You may get a few odd looks, but show doubters this article and get them exercising too! ●



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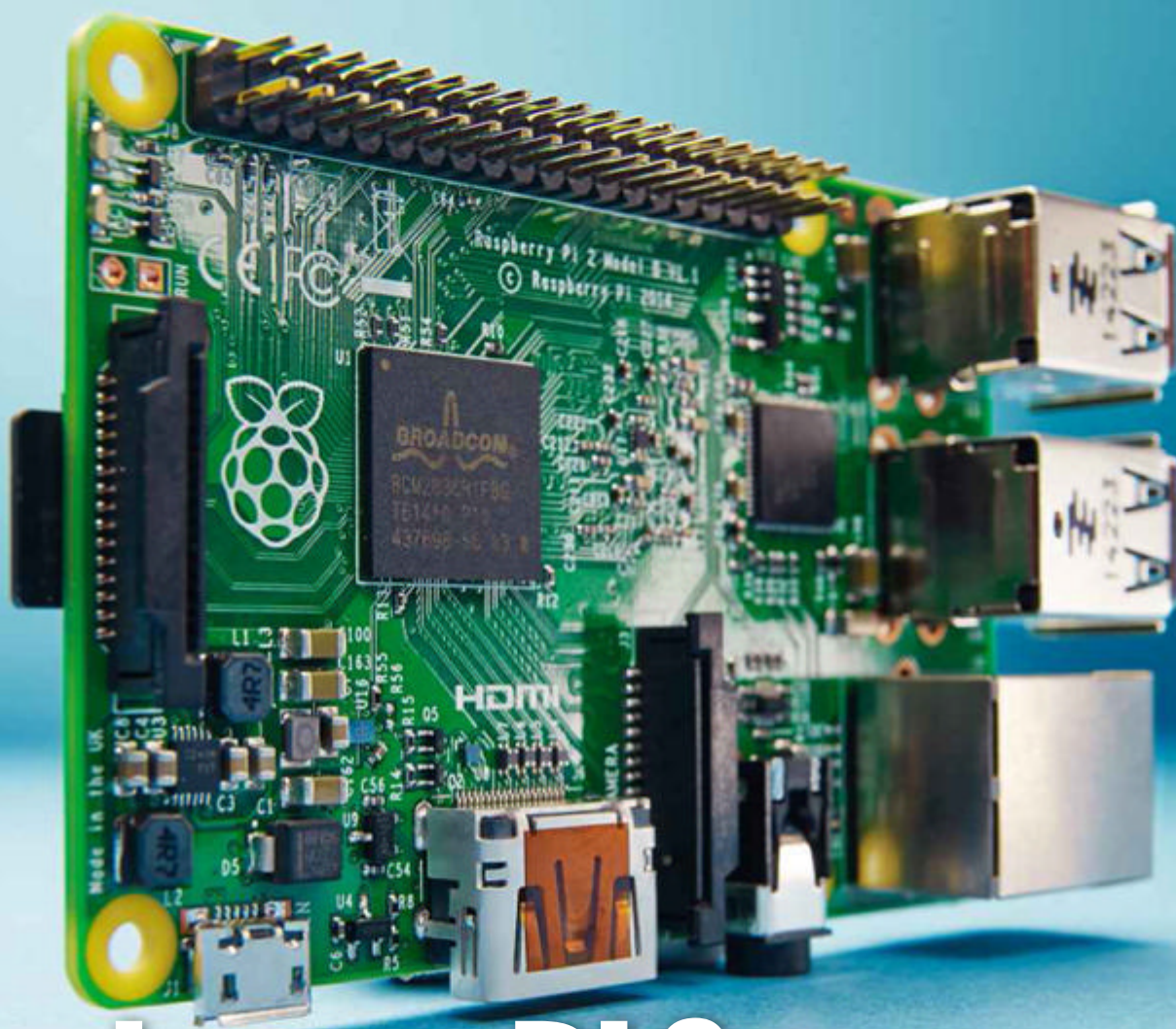
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Reviews

The biggest, best, most exciting products in tech – tested, evaluated and reviewed



Raspberry Pi 2 Model B

Still brilliant value, but now much faster – the Raspberry Pi is given a new lease of life

SCORE ★★★★★

PRICE £25 (£30 inc VAT) from element14.com (pcpro.link/247rasppi)

The Raspberry Pi has been a tremendous success story, ever since the low-cost development board first appeared in 2012. Among enthusiasts and

educators it's sparked an interest in "real" computing unseen since the halcyon days of the 1980s, and it's also inspired an army of copycat devices. Now the Raspberry Pi Foundation is building on that success with the long-awaited successor – the Raspberry Pi 2 Model B.

This isn't the first time the Raspberry Pi Foundation has updated the Pi. The Model B doubled the RAM



from 256MB to 512MB and added a second USB port, and last year the foundation released the B+, which added a further pair of USB ports, plus extra GPIO pins and an improved board layout.

The Raspberry Pi 2, however, represents the first time the company has upgraded the CPU at the heart of the computer. With the switch to a quad-core, 900MHz Broadcom

BCM2836 SoC, the new Pi is now multi-core for the very first time. It's also accompanied by 1GB of RAM, which is twice as much as the previous model, while the USB ports are now capable of supplying up to 1.2A of current to the USB ports, so you can connect more power-hungry components.

Speaking at the launch of the Raspberry Pi 2, founder Eben Upton said that the biggest challenge in developing the new device had been "hitting the price point". Yet the Foundation has managed it: although the Pi 2 represents a huge step up in computing power, it still costs only £30. The only disappointment is that the networking port remains staunchly at 10/100 speeds.

Ramifications

On the surface, the new Pi looks like a simple upgrade. It's much faster, and has more RAM, but visibly nothing changes. The placement of the ports and pins are all identical, and it's still powered via micro-USB.

By moving from the 700MHz single-core BCM2835 to the 900MHz quad-core BCM2836, however, the Pi has also moved from the ARMv6 instruction set to the more advanced ARMv7. This means the new board can support not only the Raspbian build of Debian Wheezy and previous compatible operating systems such as RISC OS and Arch Linux, but also a range of more resource-hungry OSes. Snappy Ubuntu Core was available from launch, but more should soon become available.

In even bigger news, it's been promised that the Pi 2 will eventually also support Windows 10. However, Upton has explained that this won't be a full Windows 10 environment running desktop applications: rather, a command-line environment, aimed at developers designing IoT (Internet of Things) devices.

Despite this dramatic upgrade in capabilities, the Pi 2 remains backwards-compatible with existing hardware and software projects. For upgraders, the transition should be seamless. Since the physical design is nigh on identical too, most existing third-party cases and add-on boards should also continue to work perfectly with the Pi 2. Close-fitting cases might be a problem, since some of the surface-mount components have moved, but for most users, all you'll need to do is redownload Raspbian OS to get the new ARMv7-compatible kernel.

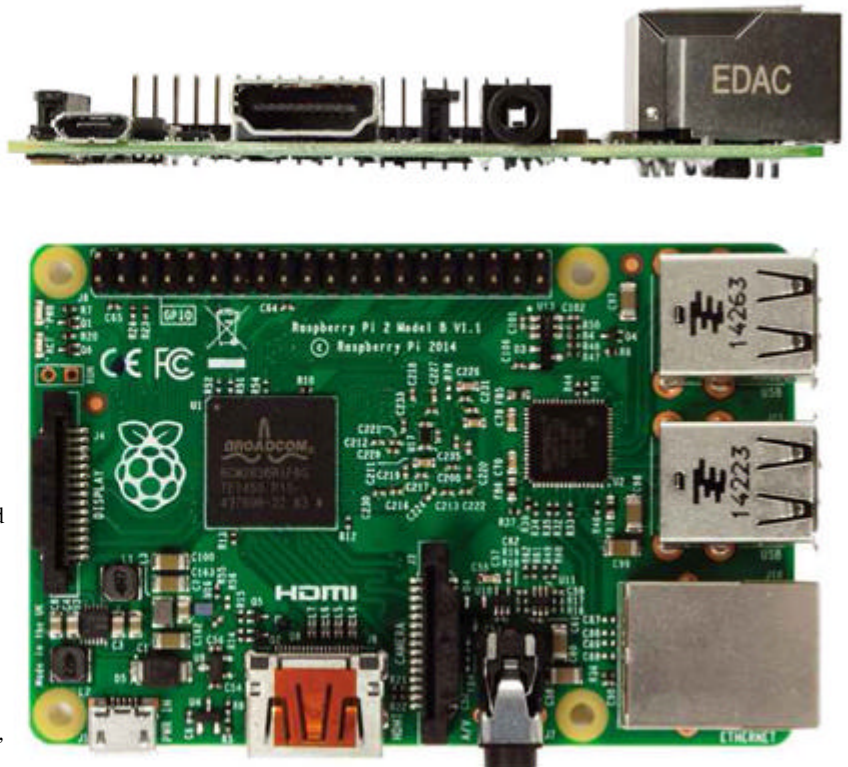
Performance

Thanks to its increased clock frequency and multiple cores, the Raspberry Pi 2 is clearly more

powerful than previous Pi models. The effective speed-up will depend on the software you're running, and whether or not it's been optimised to run multithreaded. However, at the launch, a spokesperson demonstrated a Python script that calculated an approximation of Pi then displayed it in visual form in Minecraft. The original Raspberry Pi version took 47 seconds to complete the calculation; using all four cores, the new model completed the job in three seconds.

Even in single-threaded applications, using only a quarter of the Pi 2's available compute power, you can still see a big difference. We ran SunSpider on a B+ and a Pi 2, and the latter completed the test roughly three times as quickly, with a final time of 4.487ms versus the former's 14.491ms. Running Google's Octane browser benchmark brought the B+ to its knees, returning a score of 89.7; on the Pi 2 it gained a better score of 327.

In practice, anyone who uses a Raspberry Pi to develop projects, learn programming, or as a basic desktop or media centre will really notice the bump in performance, with general tasks feeling much more responsive within the Raspbian OS. Browsing the web is no longer a chore, and the kid-friendly Scratch programming environment benefits greatly from the extra zip; you can switch between tabs without



ABOVE Although the Pi 2 looks identical to previous models, computing power receives a boost

Still only £30, but much more powerful
None we can think of

"The package is completely backwards-compatible with the previous model, so upgrading is about as painless as it gets"

having to wait seconds for them to load, and simple jobs such as importing background images complete far quicker. We tried importing a large JPEG on the B+ and the Pi 2 into a Scratch project, and found a huge difference in the amount of time it took to complete the job: on the B+ we had to wait 48 seconds before it appeared in our project; on the Pi 2 that time fell to 20 seconds.

Verdict

For those who love the Raspberry Pi and all it brings to the table, the

Pi 2 is incontrovertibly a good thing. It offers much more power, yet the price remains the same, and the package is completely backwards-compatible with the previous model, so upgrading is about as

painless as it gets.

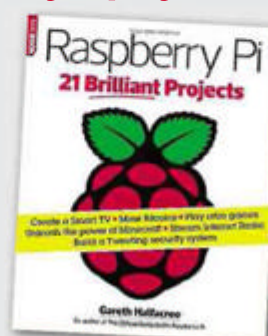
Perhaps even more significant is the extra flexibility that the ARMv7 instruction set brings with it. Having the potential to install and run a greater range of operating systems, including (eventually) a derivative of Windows 10, will only broaden the appeal of the Raspberry Pi, making the company's target of three million units shipped this year eminently achievable. **JONATHAN BRAY**

SPECIFICATIONS

Quad-core 900MHz Broadcom BCM2836 CPU • 1GB RAM • HDMI • 4 x USB 2 • 3.5mm stereo and composite video • microSD slot • 40-pin GPIO array • micro-USB power • 56 x 87 x 17mm (WDH)

21 brilliant Raspberry Pi projects

If you've ever wondered what to do with a Raspberry Pi, take a look at our guide to 21 brilliant projects. They're split into bite-sized chunks to make them easy to follow, so you'll quickly learn how to stream internet radio, build a digital photo frame, create a tweeting security system and even mine bitcoins. You can buy a copy now for £9.99 from Amazon: pcpro.link/247pi



Asus Zenbook UX303LA

The first outing for Intel's Broadwell chips hits a high note, with great stamina and a reasonable price

SCORE ★★★★★

PRICE £583 (£700 inc VAT) from
scan.co.uk/pcpro.link/247asus303

Asus' Ultrabooks have been treading the same, rather formulaic, path for some time now, with its metal-skinned Zenbook range of laptops a familiar sight in the PC Pro labs. The 13in Zenbook UX303LA doesn't break that mould, but the price is attractive, and it forges ahead in one important area: it's the first laptop we've seen to sport one of Intel's new Broadwell 14nm Core i7 CPUs.

In this case, it's the Core i7-5500U, which runs at a nominal clock speed of 2.4GHz and Turbo Boosts up to a maximum of 3GHz. It's backed up by 6GB of RAM, and since it's the same basic core design as before, it doesn't show a great performance boost over the previous generation of Haswell chips. In our Real World Benchmarks it performed well, with an Overall score of 0.75, but this is only 7% higher than the Haswell Core i5-based MacBook Air 13in we reviewed last year.

For graphics, the UX303LA boasts another upgrade, in the form of Intel's integrated HD Graphics 5500 chipset, and this helped it achieve average frame rates of 46fps at Low quality with a resolution of 1,366 x 768, and 25fps at Medium

quality and 1,440 x 900 in our Crysis tests. While this is a respectable score for an ultraportable, it still won't please avid gamers.

Overall, though, the Core i7 offers enough speed for most duties. The 128GB SanDisk SSD inside the Zenbook is no slouch either, delivering speeds of 496MB/sec and 329MB/sec for large-file read and writes in ASSD.

■ Battery life and cooling

With Broadwell, the big change is to the manufacturing process, which goes down from 22nm to 14nm – a development that promises significant power savings over

Haswell. In fact, Intel's own figures suggest

ABOVE The Zenbook UX303LA features an upgrade to a Broadwell CPU and Intel's HD Graphics 5500 GPU



✦ Fantastic battery life, strong performance and near-silent operation

✖ Broadwell doesn't offer a huge step forward in performance; squidgy touchpad is unappealing

LEFT Slim and light, the UX303LA offers true portability



overall power consumption reductions of up to 13%.

In our tests, the UX303LA delivered on this potential in spades. Tasked with the PC Pro light-use battery benchmark, which browses a series of locally stored web pages with the screen set to a brightness of 75cd/m², the Zenbook lasted 13hrs 6mins before needing a recharge. Bearing in mind that this is a Core i7, that's seriously impressive; in the same test under Boot Camp, the Haswell Core i5-based Apple MacBook Air 13in kept going for only 10hrs 8mins.

The UX303LA is also a very quiet machine: although there's a fan inside, you wouldn't know it. Even when it's running flat out, you have to put your ear directly to the vents on the rear of the machine to hear anything. The UX303LA runs cool, too, never becoming unpleasantly hot to the touch.

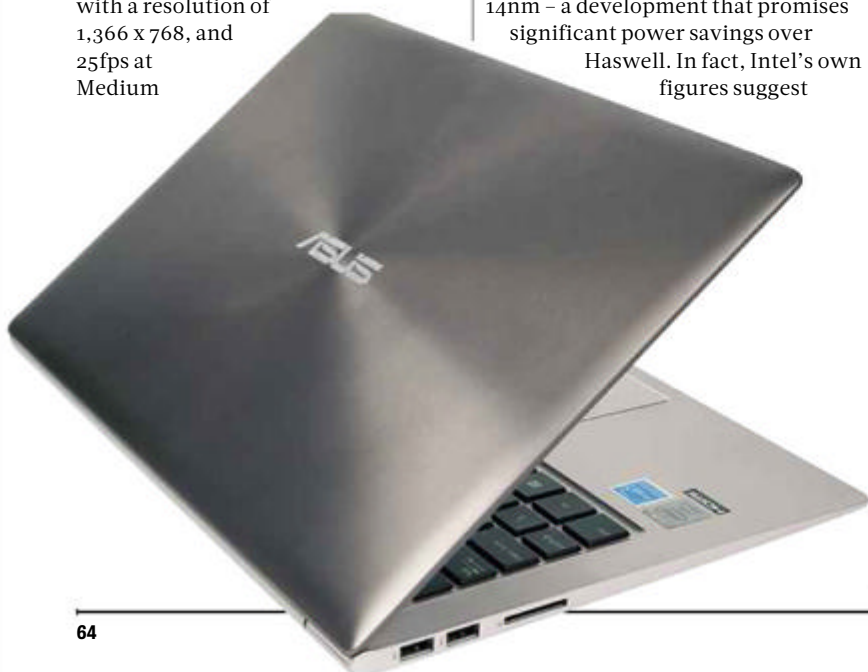
REAL WORLD BENCHMARKS

3.4GHz Intel Core i7-2600K, 4GB DDR3 = 1

OVERALL 0.75

0 0.25 0.5 0.75 1 1.25 1.5 1.75

BATTERY: light use, 13hrs 6mins





■ Design and ergonomics

Physically, the Asus Zenbook UX303LA is no groundbreaker, but this isn't necessarily a bad thing. We've always liked the Zenbook design, with its circular-patterned metal lid and matte-finish metal base. It feels solid and sturdy, capable of roughing it with the best of them.

Despite the rugged-feeling chassis, the UX303LA is slim and light, weighing 1.4kg (1.7kg with the charger) and measuring 21mm thick – it's as portable as the 13in MacBook Air, if not quite as sleek. The keyboard puts in a good showing as well, providing a decent amount of travel and plenty of feedback, as well as adjustable backlighting behind the keys.

The touchpad on Asus Zenbooks is one feature we haven't been too keen on, and the UX303LA doesn't change that opinion. While the sensitivity is fine (once you've tweaked the settings), the integrated buttons feel heavy and the clicking action squidgy. It isn't pleasant to use.

■ Screen

The Asus Zenbook UX303LA's display is a real highlight. It's a sensibly specified 1,920 x 1,080 panel with a semi-matte finish, and it uses IPS technology to deliver crisp, clear visuals and excellent viewing angles.

Measured with our X-Rite i1 Display Pro colorimeter, the screen reached a maximum brightness of 377cd/m² and a contrast ratio of 925:1. It covers 91% of the sRGB colour gamut and delivered an average Delta E of 1.93 in our tests, indicating that colour accuracy is pretty good.

Indeed, if there's one area where the UX303LA outperforms the current MacBook Air, it's here. The Air's TN display is neither as bright nor as colour-accurate, and the resolution is lower as well. Still, with new MacBook Air models expected imminently, that could change.

ABOVE The UX303LA's connectivity options are standard Ultrabook fare

■ Connectivity and audio

Since this is an Ultrabook, there's nothing special about the UX303LA's external connectivity. You get three USB 3 sockets, HDMI and mini-DisplayPort video outputs, an SD card reader and a 3.5mm headset jack. There's no Ethernet port, but Asus supplies a 10/100 USB dongle in the box, while wireless comprises 2x2-stream 802.11ac Wi-Fi and Bluetooth 4.

Finally, to round things off, the UX303LA sports Asus' usual Bang & Olufsen-branded speakers, which deliver a broad, detailed sound, but don't pack much of a punch.

■ Verdict

As expected, Intel's new Broadwell Core i7 doesn't rewrite the rulebook, certainly not in performance terms. However, its improved efficiency, coupled with Asus' budget-conscious specification, means this first outing is a positive one – and at £700 inc VAT, the Zenbook UX303LA represents superb value. It costs £150 less than the current bottom-of-the-range MacBook Air 13in, and that gets you a Core i7-based machine with a 128GB SSD, 13-hour battery life and a top-quality display. It's a lot of laptop for the money. **JONATHAN BRAY**

SPECIFICATIONS

2.4GHz Intel Core i7-5500U • 6GB RAM • 128GB SSD • 13.3in 1,920 x 1,080 IPS panel • Intel HD Graphics 5500 • Windows 8.1 64-bit • 1yr RTB warranty • 322 x 223 x 21mm (WDH) • 1.4kg (1.7kg with charger)



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You can read PC Pro in print, on your iPad, iPhone or Kindle Fire, or via our Windows 8 app.



Linx 8

Linx produces yet another compact bargain – the Linx 8 is a capable Windows tablet for a ridiculous £90

SCORE ★★★★★

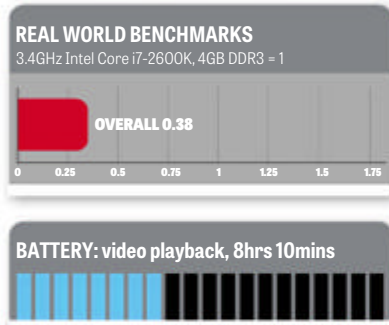
PRICE £75 (£90 inc VAT) from
pcworld.co.uk (pcpro.link/247linx8)

Not long ago, we'd have been deeply distrustful of a dirt-cheap Windows tablet – but recent arrivals such as the Bush MyTablet and Linx 10 have proven that the formula can work. Now comes the Linx 8, an 8in Atom-powered Windows tablet that retails for only £90.

When you look at what you're getting for that money, it's baffling how Linx or its rivals are making any money on these devices at all. You get a fully capable tablet running Windows 8.1 with Bing, including a year's subscription to Office 365 Personal and 1TB of OneDrive cloud storage thrown in for free. That Office 365 subscription is worth £60 on its own, and also lets you use the software on a second PC or Mac.

The Linx 8 is a smart-looking device too. The all-black chassis won't wow the fashion police, but curved edges and a grippy matte-black rear make it easy to wield in one hand. Plus, at 377g it's no heavyweight.

Cast an eye around the Linx 8's



body and you'll find that all the basics are covered. There's a micro-USB port for charging, a micro-HDMI port, a headphone socket, and a microSD slot for expanding the Linx 8's 32GB of onboard storage. With a third-party OTG cable, you can also connect USB keyboards, thumbdrives or even a USB hub – although you won't be able to charge the tablet at the same time.

On the wireless front, Bluetooth 4 provides an alternative means of connecting a keyboard and mouse, while single-band 802.11n wireless networking is par for the course.

Rather than a physical Windows button, Linx has opted for a capacitive sensor on the tablet's lower bezel. It's easy to brush by accident, which can be annoying when you're in the midst of a game or working on a document, but it's easier to reach than the Bush's tiny edge-mounted button.

As usual with such low-cost tablets, the front- and rear-facing 2-megapixel cameras are desperately poor,

LEFT The Linx 8 looks smart, with curved edges and a grippy matte-black rear

ABOVE The Linx 8 runs Windows 8.1 with Bing and includes a one-year subscription to Office 365

"Battery life isn't to be sniffed at: with brightness dimmed and Wi-Fi off, the Linx 8 played back our movie on repeat for 8hrs 10 mins"

✚ Amazingly cheap, Office 365 subscription included
— Only 1GB of RAM

both capturing smeary photos and videos. They're just about good enough for video chat, but little else. The rear-firing pair of speakers are better: they're loud and clear enough to let you enjoy the odd video without reaching for the headphones.

The 8in, 1,280 x 800 IPS display delivers decent image quality with good viewing angles. The maximum brightness of 292cd/m² is noticeably brighter than the Bush MyTablet, and contrast reaches a remarkable 1,257:1 – so high that we suspect dynamic contrast is at play behind the scenes.

Colours aren't particularly great, however. Whites have a cold, blue tint to them, and skin tones look slightly off. Primary tones are dull and faded, and our measurements showed that the panel covered only 67.4% of the colours in the sRGB gamut – visibly short of the Bush MyTablet's 78.3%.

Performance is pretty darned good. The Linx 8 is powered by Intel's quad-core Atom Z3735F and, despite the frugal 1GB of RAM, the subjective experience is pretty good. Even heavyweight applications such as Adobe Photoshop and Sony Vegas Pro are surprisingly usable; it's only once you start trying to run multiple applications side by side that the Linx 8's hardware reaches its limits. In our Real World Benchmarks, it achieved a result of 0.38 – a score identical to the Bush MyTablet's.

Battery life isn't to be sniffed at either: with the screen brightness dimmed to 120cd/m² and Wi-Fi off, the Linx 8 played back our 720p movie on repeat for 8hrs 10mins, around half an hour longer than the Bush.

For £90, the Linx 8 is hugely appealing. Responsiveness, build quality and the range of features on offer are far in excess of what you'd

expect for the money. Not much differentiates it from the Bush MyTablet, but in our view the Linx 8 edges ahead for looks while also winning for battery life – although video and gaming

fans may prefer the Bush's more colourful display.

Another factor that may sway potential purchasers is a £30 cashback deal if you trade in your old tablet, bringing the balance to a preposterously low £60. At that price, we suspect most people won't need much convincing. **SASHA MULLER**

SPECIFICATIONS

1.33GHz Intel Atom Z3735F (up to 1.83GHz) ● 1GB RAM ● 32GB eMMC storage ● 8in 1,280 x 800 LCD ● microSD ● micro-HDMI ● Windows 8.1 with Bing 32-bit ● 1yr warranty ● 125 x 8.9 x 215mm (WDH) ● 377g

Hannspree Micro PC

A tiny PC with huge potential, the Micro PC looks set to be the first of many pocket-sized desktops

SCORE ★★★★★

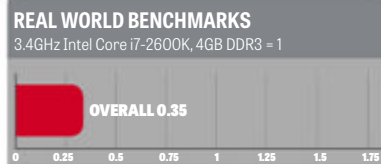
PRICE £125 (£150 inc VAT) from dabs.com
(pcpro.link/247micropc)

Monitor manufacturer Hannspree may not be the first name that sprung to mind when you think of dramatic innovation in desktop PCs, but its latest product could change all that. The Hannspree Micro PC (also known as a “PC on a Stick” by some retailers) is a full-blown Windows 8.1 (with Bing) PC, squeezed into a package that’s only a touch bigger than a Chromecast.

It weighs a mere 38g, measuring 38 x 110 x 10mm (WDH) and, just like a Chromecast, it plugs directly into a TV or monitor via HDMI. Since HDMI doesn’t carry any power, you need to plug it into the supplied mains adapter as well, or a spare USB socket in the back of your TV or monitor. But aside from that, all you need to add is a keyboard and mouse.

Despite its size, the Micro PC runs full Windows 8.1. In fact, it has the same core hardware as the Linx 10 tablet (pcpro.link/linx10) we reviewed recently: an Intel Atom Z3735F running at a base frequency of 1.33GHz, with Turbo Boost up to 1.83GHz, along with 2GB of RAM and 32GB of eMMC flash storage.

As a result, Windows feels spritely in everyday use. Explorer windows fire up without delay, as do hefty web pages, and the Windows Start screen scrolls by without a hiccup. Multitasking can slow things down a touch, and you wouldn’t want to do much video



editing on it, but for browsing and office work it’s fine.

In testing, the Micro PC performed as expected, scoring 0.35 in our Real World Benchmarks – a result that’s on a par with most other Atom hardware we’ve tested recently. However, we had to drop from the usual Full HD resolution to 1,280 x 800 to get the Photoshop test to work without throwing out-of-memory errors. Clearly, 2GB of RAM is teetering on the borderline of acceptability for a Windows machine running at 1080p; however, running Photoshop on such a system is an edge case anyway.

There are other, more practical concerns. Although there’s a surprising amount of connectivity here – around the edges you’ll find a full-sized USB 2 port and a microSD slot that will accept up to a stated maximum of 64GB – in practice, you may need to work around the Micro PC’s limitations. For instance, you’ll want to keep a USB keyboard and mouse handy for use in emergencies (or if you put the machine into flight mode by accident), and you’ll certainly need these to hand when setting up the Micro PC initially.

A powered USB hub will be convenient, too, if you want to add an external mechanical disk for storage or backup – and with only single-band, single-stream 802.11n on board, wireless speeds will be limited, so it may be a good idea to invest in a USB Ethernet adapter as well.

The big question concerns the target market for the Micro PC. The manufacturer was vague when asked about this, saying merely that the device is “for anyone who needs to save space” – or who wants an

ABOVE The Micro PC puts a full-blown Windows 8.1 computer in your pocket

“Clearly, 2GB of RAM is teetering on the borderline of acceptability for a Windows machine running at 1080p”

+ Tiny, portable and surprisingly usable as a desktop machine
— Price is a little high considering the competition; only single-band 802.11n

LEFT Despite its size, the Micro PC features a full-sized USB 2 port and a microSD slot

ultra-portable PC to carry around with them.

One practical suggestion was that customers might want to team the Micro PC with one of Hannspree’s two touchscreen monitors. Plug it into the 23in HT231HPB display (around £150 inc VAT), and it turns into an ultra-cheap, sub-£300

all-in-one machine.

And we can certainly see the appeal for other fields of work, too: as a backup machine for when you’re working on the road, for instance.

In a modern office it could serve as the ultimate hot-desking tool. IT support workers might also find a use for it, and alongside something such as XBMC, it could serve as an ultra-low-profile media-centre PC as well.

Ultimately, while we love the idea of the Hannspree Micro PC, it’s a bit of a niche product. Most people won’t need a PC they can fit in their pocket, and anyone for whom this might be tempting would do well to first consider either a Windows with Bing laptop such as the Toshiba CL10-B (pcpro.link/satcl10), or one of the wave of ultra-cheap Windows tablets that’s emerging onto the market. While you could never accuse the Micro PC of being overpriced, these devices represent even better value for money. **JONATHAN BRAY**

SPECIFICATIONS

1.33GHz Intel Atom Z3735F (1.83GHz burst speed) • 2GB DDR3 RAM • Intel HD Graphics • 32GB eMMC storage • HDMI • USB 2 • micro-USB • microSD • single-band 802.11n Wi-Fi • Bluetooth 4 • Windows 8.1 32-bit • 2yr RTB warranty • 38 x 110 x 10mm (WDH) • 38g





Windows 10 Technical Preview for phones

Microsoft kicks off the evolution of its mobile OS with a host of subtle yet significant changes

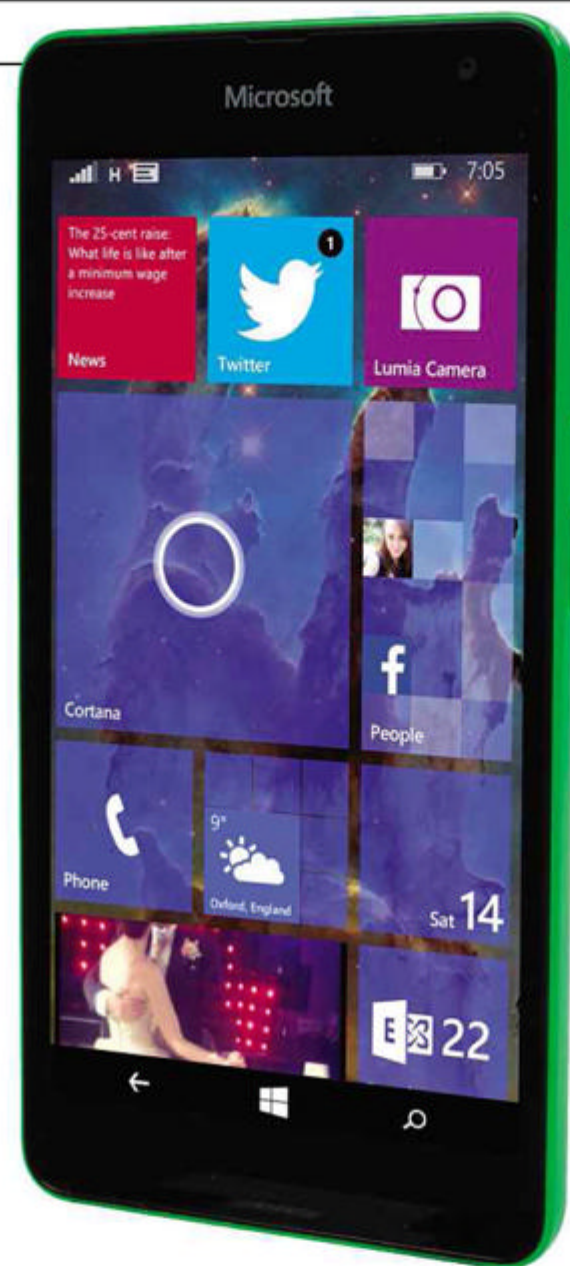
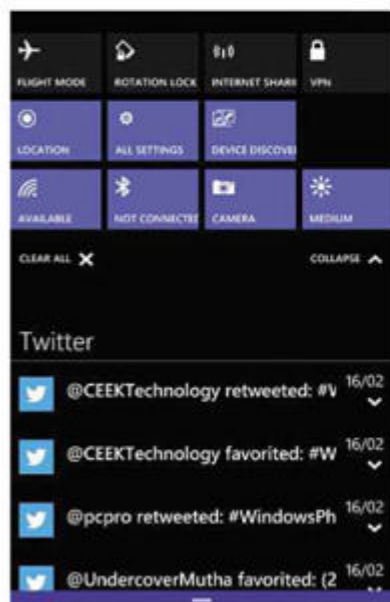
COMPATIBLE PHONES Nokia Lumia 630, 635, 636, 638, 730 and 830

At the end of last year, Microsoft unveiled its vision for the future of Windows: not only the desktop, but also on smartphones, tablets and other connected devices. Until now we've only been able to get a feel for Windows 10 on the desktop – what's changed is that the next piece of the puzzle has been made available: Windows 10 for phones.

Just like the desktop OS, the smartphone version is a Technical Preview, available to anyone with a compatible Windows Phone 8.1 handset who registers with the Windows Insider Programme (see p12 for how to sign up). We've installed it on a Nokia Lumia 630, but you can also try it out on the compatible phones listed above.

■ So what's new?

At first glance, you'd be forgiven for wondering what all the fuss is about. The lockscreen and homescreen look largely as they did in Windows Phone 8.1, and that's a good thing. After all, Windows Phone's biggest strength, and what sets it apart from Android and iOS, has always been its vertically scrolling, data-rich Live Tiles.



It doesn't take much digging before the changes begin to emerge, and the most profound are to be found in the Action Center notifications menu.

The first time you look, you'll see the same four toggle buttons along the top of the menu, with notifications lined up beneath. Look closer, though, and you'll see some subtle alterations.

The All Settings shortcut has disappeared, to be replaced by Expand. Tap this and the single row of shortcut buttons grows to three rows, allowing quick access to all 11 of Windows Phone's available shortcuts. It's still possible to customise the four that appear by default, but you can't currently remove or add items to the expanded list.

Below the shortcut buttons, notifications have also received an upgrade, but this is far more significant. To the right of each notification now sits a small down arrow. Tapping this expands items, allowing you to either read more or

LEFT The shortcut buttons in the Action Center can be expanded to show 11 items

ABOVE You'll see a couple of new tile sizes on the Windows 10 homescreen, plus background images that fill the screen

"The eventual aim is to unify both platforms and have developers produce universal apps that share the UI and feature set"

interact with them. Currently, the range of apps that hook into this capability is limited: you can respond directly to text messages, but not emails.

This also applies to the pop-down alerts that appear at the top of the screen, although it's fiddly at the moment: you need to tap a thin bar below the notification; swiping down doesn't work. Hopefully, Microsoft will have addressed this by the time the software is finally released.

Tuck the notifications menu away for a moment, and you may also notice a tweak or two to the look of the homescreen. Background wallpapers that were previously displayed rather oddly – only through individual tiles, as if they were windows onto the image behind – now fill the entire screen. And some tiles, such as those for Outlook and Internet Explorer, are now translucent.

There are a couple of new tile sizes as well: a 4x4 square and a 2x4 rectangle, although currently only a few apps are compatible with these sizes. Swipe right to Windows Phone's alphabetical list of apps, meanwhile, and you'll see a list of recently installed apps conveniently displayed in a group at the top of the list for easy access.

■ Unified look and feel

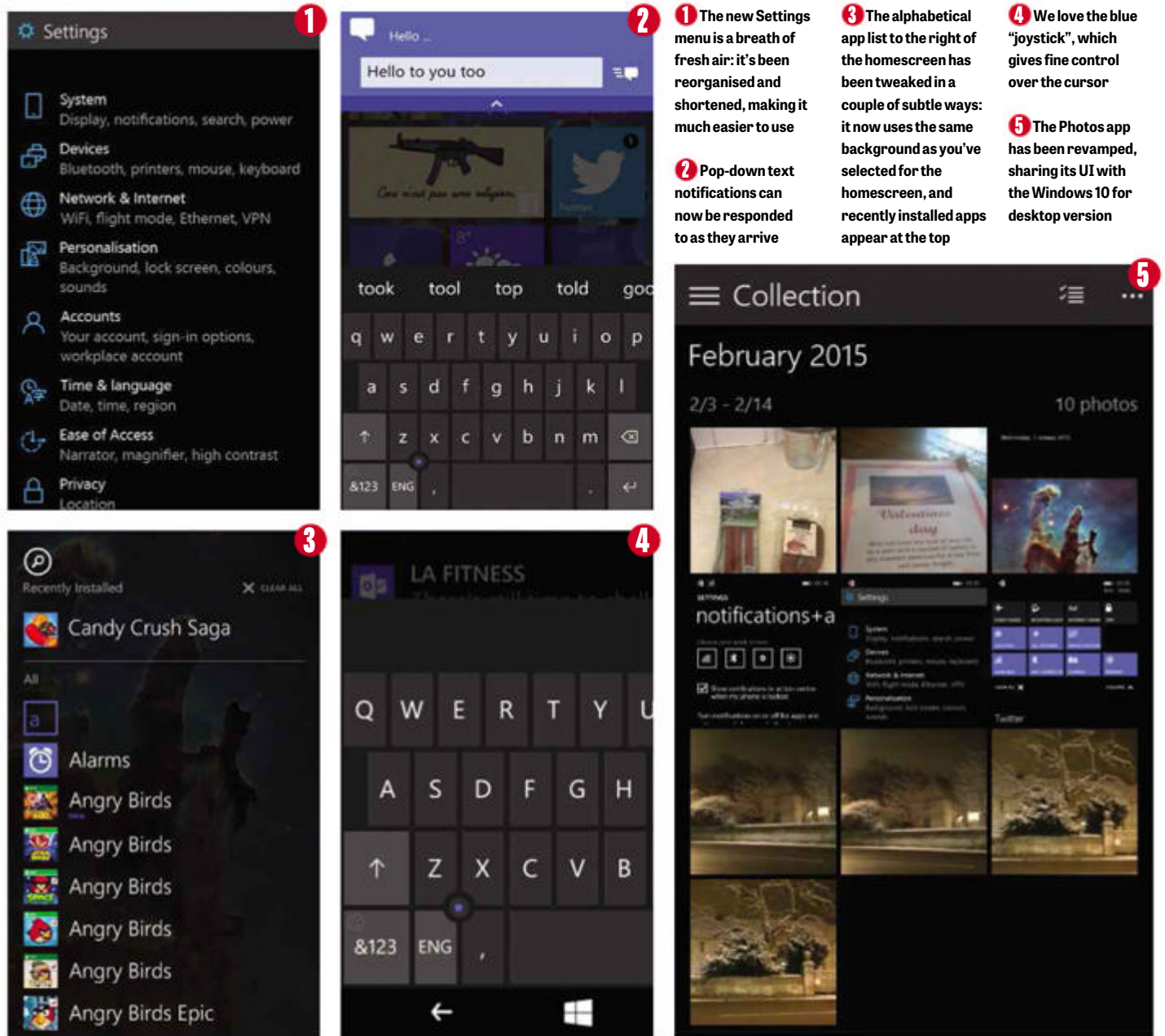
With Microsoft even merging the names of the desktop and mobile operating systems, the eventual aim is to unify the two platforms so that there's consistency across them. Equally crucial, developers will be able to produce universal apps that share the UI and feature set across the two platforms as well.

The work isn't complete, but you can see where Microsoft is going with this. In the Settings menu, each entry is now accompanied by the same wireframe icon as used on the desktop version of Windows 10, plus fonts match too.

Microsoft has also rationalised and organised the list of items in the Settings menu. In Windows Phone 8.1, you'll find no fewer than 50 items in a vertically scrolling list, arranged in no kind of order; in Windows 10 for phones, these items are organised

into ten thought-through categories, under titles such as Network & Wireless, Accounts, and Time & Language. As a result, it's much easier to find what you're looking for.

The redesign of some core apps is another indicator of how the design of Windows Phone is set to change this year. The Photos app, for instance, already shares the



layout and UI of the Modern app on Windows 10 for desktop. Perhaps more significantly, it also does away with Windows Phone's characteristic sideways swipe for navigation in favour of a single-screen view with pop-up menus.

The dialler and calculator apps have seen a similar revamp. Cortana now shares the desktop app's look and feel as well, and there's set to be much broader text-to-speech support in Windows 10 for phones. These features are currently restricted to US residents, although those in the UK can get them partially working by changing the language, region and speech settings to US English.

■ What isn't working yet, and a "key" new feature

Not everything promised in the launch announcement for Windows 10 for phones is working yet. One such

example is the unified notifications system, dubbed Continuum, which will eventually tie your phones, tablets, laptops and desktops all together in one homogenous whole. When this is working, the idea is that you should be able to dismiss an alert on the desktop, and it should then disappear on your phone as well. And vice versa.

However, we did spot one small improvement that works very well indeed. The keyboard now sports a small blue dot nestling in the junction between the Z, X and comma keys. This acts as a four-way virtual joystick: press and hold it in any direction for fine control of the cursor.

■ Initial verdict

It's clearly early days for Windows 10 for phones, and there's a long way to go for Microsoft's developers. There's

1 The new Settings menu is a breath of fresh air: it's been reorganised and shortened, making it much easier to use

2 Pop-down text notifications can now be responded to as they arrive

3 The alphabetical app list to the right of the homescreen has been tweaked in a couple of subtle ways: it now uses the same background as you've selected for the homescreen, and recently installed apps appear at the top

4 We love the blue "joystick", which gives fine control over the cursor

5 The Photos app has been revamped, sharing its UI with the Windows 10 for desktop version

✚ A glimpse of the future of Windows Phone, with a lot of worthwhile improvements
 — Very unfinished as yet; the app problem is unlikely to go away

plenty here that's incomplete, not yet working, or just plain buggy.

None of what we've seen so far is likely to improve Microsoft's biggest problem, which is the lack of depth of apps that work across both phone and desktop in the Windows Store. We're also yet to see how Microsoft's universal apps strategy is going to pan out with third-party developers.

However, there is encouraging evidence that Microsoft's developers have sat down and had a long, hard think about how to take Windows Phone forward in a constructive manner. They've been thinking not only about the best way to bring about the marriage between desktop and smartphone, but also how to improve the experience for smartphone users in general. We await the next chapter with great interest. **JONATHAN BRAY**

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- 3 Year Premium Warranty
- Microsoft Windows 7 Home Premium 64-bit

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- 4GB NVIDIA GeForce GTX 970
- 120GB SSD + 240GB SSD
- 3 Year Premium Warranty
- Microsoft Windows 7 Pro 64-bit

£1939 Inc VAT



This high performance 3XS system is optimised for editing 4K video with an overclocked six-core Intel Core i7 5820K plus a 120GB SSD for Windows plus a dedicated super-fast 240GB SSD for your current project.



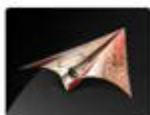
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- Microsoft Windows 7 Home Premium 64-bit

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- Microsoft Windows 7 Pro 64-bit

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The GW-HT20 features the 8-core Intel Core i7 5960X CPU with Hyper-Threading which we overclock to 4.2GHz. This very powerful CPU is partnered with the high-end 4GB NVIDIA Quadro K4200 graphics card. Also included is 16GB of high bandwidth 2666MHz Corsair DDR4, a 250GB Samsung SSD and 2TB Seagate hard disk.



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- Microsoft Windows 8.1 64-bit

£1539 Inc VAT



Our highly popular Vengeance gaming system is based around the immensely powerful NVIDIA graphics card, the 4GB GeForce GTX 980. To make that the GTX 980 isn't held back this awesome gaming PC also includes an Intel Core i7 4790K overclocked to 4.7GHz which is accompanied by 8GB of RAM, a 240GB SSD and 2TB hard disk.



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- 32GB Crucial 2133MHz DDR4 ECC
- 4GB NVIDIA Quadro K4200
- 240GB SSD + 2TB HDD
- 3 Year Premium Warranty
- Microsoft Windows 7 Pro 64-bit

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The GW-HTX30 marks a giant leap forward in performance thanks to having two 8-core Intel Xeon E5 2640 V3 CPUs. These are partnered with a 4GB NVIDIA Quadro K4200 professional graphics card and 64GB of 1600MHz ECC Registered DDR3 plus a 240GB SSD and 2TB HDD.



3XS Graphite LG1720

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- 17.3" FullHD 1920 x 1080 screen
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- 3GB NVIDIA GeForce GTX 970M
- 3 Year Premium Warranty
- Microsoft Windows 8.1 64-bit

£1159 Inc VAT



The LG1720 is a 17.3" high-end gaming laptop that includes a choice of powerful NVIDIA GeForce GTX 970M or 980M graphics card, ensuring silky smooth frame rates in all games. The LG1720 is ready for next-day delivery and has a 2 Year Warranty.



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3XS SYSTEMS



Asus ProArt PA328Q

A good-quality 4K IPS monitor for reasonable money, but a couple of flaws mar its appeal

SCORE ★★★★★

PRICE £905 (£1,086 inc VAT) from uk.insight.com (pcpro.link/247asproart)

While 4K monitors are gaining popularity, we haven't so far seen one that delivers true professional quality. The 32in Asus PA328Q aims to change that, with a 10-bit IPS panel, factory-calibrated sRGB mode and a wealth of inputs and settings – all for a reasonable £1,099 inc VAT.

The star of this particular show is the panel: Asus claims it covers 100% of the sRGB colour gamut, and the combination of that pre-calibrated sRGB mode and a 12-bit lookup table suggest it should be able to serve up colour-accurate images.

It's fair to say that the PA328Q looks the business, too. The bezel is elegantly thin, and a semi-gloss finish keeps reflections at bay. Around the rear, the stand provides 130mm of height adjustment, and lets the screen spin smoothly into portrait mode.

The monitor has mini-DisplayPort, DisplayPort and HDMI 2 inputs, all three of which will accept a full 3,840 x 2,160 4K signal at 60Hz. There are also a further two HDMI 1.4 ports, both of which can accept a 30Hz signal. Handily, the HDMI 2 port also doubles as an MHL 3 input, for a 30Hz 4K signal from a compatible tablet or smartphone. To top it all off, there's a built-in four-port USB 3 hub too.

The onscreen menu offers an impressive array of options, with everything from picture-in-picture and side-by-side options to six-axis hue and saturation adjustments. Navigating the menu is fiddly, though, with the buttons and four-way mini-joystick unhelpfully mounted on the rear of the display.

While everything looks good on paper, first impressions are spoilt by Asus' VividPixel feature, which gives both text and photos an ugly, over-sharpened look. Turn it off, and the PA328Q serves up some truly gorgeous images.

RIGHT The PA328Q doesn't lack for ports, and its screen can be spun into portrait mode



The sheer number of pixels makes for incredible clarity, and the IPS panel serves up bold, natural-looking colours with wonderfully wide viewing angles. A maximum brightness of 360cd/m² and a contrast ratio of 882:1 deliver an eye-popping experience whether you're watching a movie, playing games or editing photos, and no obvious visual anomalies such as smearing or ghosting spoil the show.

The Asus' factory-calibrated sRGB mode also racks up some solid numbers. We measured the panel as covering 99.9% of the sRGB colour gamut, and average and maximum Delta E figures of 1.23 and 4.34 prove that colour accuracy is very good, if not exemplary. Colour temperature was right on target, with the Asus' 6,447K result a whisker away from a perfect 6,500K.

The PA328Q does have weaknesses, first among which is a tendency to smudge the darkest greys into black. Backlighting isn't particularly even, either, and as the Uniformity Compensation feature and brightness controls are disabled in sRGB mode, there isn't much you can do to improve matters. As a result, a clean white screen looks dim and dirty around the edges, with brightness dropping by around 17% across the right-hand edge and as much as 21% along the left.

ABOVE The generous number of pixels ensures the PA328Q is able to offer superb clarity

"A brightness of 360cd/m² delivers an eye-popping experience whether watching movies, playing games or editing photos"

✚ Covers 99.9% of sRGB gamut; lots of connectivity; flexible design
✚ No hardware calibration; inconsistent brightness in sRGB mode

Switching to Standard mode and engaging Uniformity Compensation reduces the deviation to little more than 4% across most of the screen, without impacting severely on colour accuracy. Oddly, though, we found it created a noticeable bright spot in the bottom right of the panel, where brightness measured between 10% and 12% higher than at the centre.

The Asus PA328Q is a very good monitor, but it isn't the affordable 4K professional panel we were hoping for. Not only is the lighting uneven, there's no hardware calibration, so the factory-calibrated sRGB mode will lose accuracy as the panel ages. You can of course soft-calibrate with a

third-party colorimeter, but that costs extra, and won't do for proper professional use.

Still, those looking for a 4K monitor that's a cut above the cheaper TN models (such as Asus'

own £450 PB287Q) will find the PA328Q ticks a lot of boxes. It's great for colour-accurate dabbling in Photoshop, watching movies and playing games with a suitably super-charged graphics card. But if you're looking for a professional 4K display, we suggest you opt for the £1,400 Eizo ColorEdge CG277 (pcpro.link/247eizo) instead. If your work demands colour accuracy, it's well worth the premium. **SASHA MULLER**

SPECIFICATIONS

32in 3,840 x 2,160 IPS panel • DisplayPort • mini-DisplayPort • HDMI 2/MHL 3 • 2 x HDMI 1.4 • 4 x USB 3 • 3yr RTB warranty • 735 x 240 x 615mm (WDH)

Eizo ColorEdge CG318-4K

Eizo goes beyond 4K to create the best monitor we've ever tested – time to dust off the credit card

SCORE ★★★★★

PRICE £3,333 (£4,000 inc VAT), available from April

Eizo's newest self-calibrating 4K monitor has a list of specifications that read like a design or broadcast professional's Christmas list.

For a start, Eizo has reached beyond the Ultra HD resolution to support the full Digital Cinema (DCI) 4K standard resolution of 4,096 x 2,160. Stretched across a 31.1in IPS panel, this delivers a pixel density of 149ppi – pin-sharp, from normal monitor viewing distances.

This huge canvas is illuminated by an impressively even LED backlight. We measured 15 points on the panel and found most deviated by no more than 2%, with a peak of 4.4% in the top-left corner. That's barely noticeable, and well within the bounds we'd demand from a high-end display – 100% perfect backlighting simply doesn't exist.

Colour reproduction is excellent. Tested in sRGB mode with our X-Rite i1Display Pro colorimeter, the CG318-4K covered 99% of the gamut, with an average Delta E of 0.46 and a maximum deviation of 1.27. Contrast hit an exemplary 1,204:1 and colour temperature an almost-perfect 6,522K. Switching to Adobe RGB threw up almost identical results: 99% gamut coverage, with an average Delta E of 0.59 and a maximum of 1.26. Contrast hit 1,204:1 and colour temperature 6,495K.

It's all rounded off with Eizo's anti-glare finish, so grain and



shimmer are non-issues. Blacks remain deep and lustrous, and motion is smooth and judder-free. The overall effect is one of astonishing clarity for both still and moving images.

One minor reservation we've had about previous ColorEdge monitors is their chunky design, but the CG318-4K's bezels are pleasingly narrow. Plus, despite the size of the panel, the chassis is slender. The stand won't spin into portrait mode, but it provides 149mm of height adjustment and swivels left and right, with a carry handle at the rear and a shading hood to keep reflections at bay.

Connectivity hits the mark too. You get twin HDMI and DisplayPort inputs: both support 10-bit colour, and a single DisplayPort 1.2 connection is all that's required to carry a 60Hz full-resolution 4K image. There's also a three-port USB 3 hub on the monitor's left-hand edge.

The CG318-4K features an updated onscreen display and new ColorNavigator software, which make it easier than ever to access the built-in calibration and colour modes. You won't need to access these often, though: the combination of an integrated colorimeter and factory presets for all the major design, broadcast and cinema standards mean the CG318-4K is as close to a fit-and-forget monitor as you could ask for.

Simply choose from the comprehensive array

ABOVE The CG318-4K is the ideal monitor for professionals whose work demands colour-accurate images



"Grain and shimmer are non-issues. Blacks remain deep and lustrous, and motion is smooth and judder-free"

Simple to use and the quality is stunning; the finest monitor we've seen

Nothing apart from the price

of preset colour targets (besides the familiar sRGB and Adobe RGB modes, the CG318-4K also supports Rec. 709, Rec. 2020, EBU, DCI and SMPTE-C as standard); then select when and how often you'd like the self-calibration process to take place, and the monitor takes care of it. If you wish, you can tweak the monitor's self-calibration schedule and configure your own brightness, white point, black point and brightness levels. And once everything is configured just so, you can lock out the monitor's controls so that others can't unwittingly compromise the desired settings by fiddling with the onscreen display.

For everyday desktop computing, the idea of splashing £4,000 on a

monitor is plainly absurd.

But for professionals whose work demands pixel-perfect, colour-accurate images, the ColorEdge CG318-4K is a fantastic investment.

Take into account the five-year on-site warranty, and the fact that the monitor's brightness and colour accuracy are warrantied for 10,000 hours of use, and it adds up to a package that will surely find a loving home in studios and editing suites worldwide. And rightly so – it's the best monitor ever to pass through PC Pro's labs. **SASHA MULLER**

SPECIFICATIONS

31.1in 4,096 x 2,160 IPS LCD panel • 2x DisplayPort • 2x HDMI • 3x USB 3 hub ports • 5yr on-site warranty • 735 x 245 x 434-583mm (WDH)

RIGHT The stand swivels left and right and features a carry handle at the rear



Netgear R7500 Nighthawk X4

The interface is clunky – but this is a capable and well-featured router delivering excellent performance

SCORE ★★★★★

PRICE £150 (£187 inc VAT) from broadbandbuyer.co.uk (pcpro.link/247NetgearR7500)

Netgear's latest flagship router introduces a new AC2350 transfer mode, which ups the ante over last year's AC1900 models with a speed bump and improved multi-user performance.

As with other dual-band routers, the AC2350 number doesn't refer to a single 2,350Mbps/sec signal; it's the combined maximum throughput of both the 2.4GHz and 5GHz bands. The AC1900 specification increased the bandwidth in the 2.4GHz band from 450Mbps/sec to 600Mbps/sec, and with AC2350 it's the turn of 5GHz to get a boost, from 1,300Mbps/sec to 1,733Mbps/sec. That gives a theoretical total of 2,333Mbps/sec, which Netgear rounds up to AC2350.

As the name suggests, the Nighthawk R7500 X4 sports a 4x4 antenna array with MU-MIMO capabilities. This means it can use beamforming to enhance range and speed for up to four clients at once.

The four external aerials are bolted to a chassis with a whopping footprint of 285 x 184.5mm, and stick upwards by around 200mm. The router can also be wall-mounted, but note the body alone juts out 50mm. As with previous Nighthawk routers, there's a military feel to the styling, with build quality to match.

At the left and right edges sit two USB 3 ports and an eSATA port respectively, while at the back you get four Gigabit Ethernet ports. That's pretty standard, but at this price we'd hoped for more sockets. Note, too, that there's no input for a DSL line or other WAN pipe: this is a standalone router.

Also round the back is a switch to turn off the front

lights, to reduce distractions in your living room. Since it's a hardware switch (rather than a software setting), you can easily turn the lights back on for troubleshooting if needed. You also get elegant backlit buttons for WPS and toggling Wi-Fi on and off.

Disappointingly, the UI doesn't live up to the high design standards. It's functional but slow, and lacks useful features, such as a way to specifically set the Wi-Fi channel bandwidth and mode.

The Netgear Genie desktop software didn't thrill us either: it helped us set up the router and track network activity, but we're not fans of the sideways-scrolling interface.

Perhaps the most awkward aspect of the R7500's interface is the process of configuring a second unit as a Wi-Fi bridge. This is, for now, the only way to take full advantage of its speed and range, since there are currently no 4x4 receivers on the market.

Sadly, setting it up is tedious: you can't simply search for your main router, but must manually configure the SSID and security settings. Still, once you're up and running, the R7500 performs admirably in bridge mode.

With a pair of routers 2m apart, we saw transfer speeds of 82.7MB/sec – compared to the 76.8MB/sec achieved by connecting via Asus' PCE-AC68 AC1900 receiver. Using the same Asus receiver, the rival Linksys EA6900 delivered 70.1MB/sec.

ABOVE The R7500 is a beefy router and produced a powerful set of transfer speeds to match



“The R7500 Nighthawk X4 can use beamforming to enhance its range and speed for up to four clients at once”

+ Fast transfer speeds, even at long range

– Pricy, and the user interface is unrefined

Moving the test setup to 5m away, with a brick wall in the way, the Netgear struggled to a much slower 32.5MB/sec, while the Linksys only dropped to 44.6MB/sec. However, moving further away still (15m with two brick walls) saw the Netgear hold up to 27.8MB/sec, while the Linksys fell to 20.7MB/sec.

The R7500 is also a solid performer over 802.11n, delivering 16.5MB/sec, 14.4MB/sec and 7.3MB/sec in the same test scenarios, compared to 19.3MB/sec, 13.1MB/sec and 6.7MB/sec for the Linksys. USB NAS performance is excellent too: here the Netgear delivered 60.8MB/sec compared to the Linksys' 37.5MB/sec.

A final key feature is the enhanced QoS, which tracks the applications

being used to ensure time-sensitive apps get data promptly. This is difficult to test, but we tried streaming HD video while performing hefty file transfers and saw no hiccups.

All told, the Netgear R7500 Nighthawk X4 would benefit from a slicker UI, and there aren't many devices out there that will be able to take full advantage of its speed. If you're seeking the very best performance and range from your router, however, it's a great choice. **TOM BROAD**

SPECIFICATIONS

4x4 stream 802.11ac router • 1,733Mbps/sec for 802.11ac; 600Mbps/sec for 802.11n • 4 x Gigabit Ethernet • 2 x USB 3 • eSATA • 2yr RTB warranty • 285 x 184.5 x 50mm (WDH)



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Workstation PCs

Need more grunt than a standard PC can offer? We test seven of the most powerful rigs on the planet



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Most of us don't need a huge amount of computing power in our day-to-day working lives. For many, a lightweight, low-powered laptop, even a Chromebook, is good enough. But for some only the best will do. Anyone whose job involves digital content creation - video editors, 3D designers, architects, photographers - will need a higher grade of hardware.

In many cases, this means a workstation: a powerful, specialised desktop PC (or even a laptop) designed for professional tasks. When purchasing one, however, the devil is in the detail. The software you plan to use will dictate the components worth spending money on. Some activities benefit from more processor cores; some from a faster processor frequency; some from extra memory; and some get a major boost from expensive 3D graphics acceleration. A fast hard disk is essential for video editing, but less crucial for other applications. In this Labs, we'll be looking at a range of workstations that represent a cross-section of what's available for many of these tasks.

■ 3D modelling and rendering

3D animation is one of the most important types of professional activity for which a specialised workstation is needed. The work is divided into two areas, each with different requirements. Modelling - the process of designing and building 3D objects and characters - is an interactive activity that requires the greatest

real-time responsiveness available. However, modelling software isn't generally highly multithreaded, so a fast CPU clock speed is more beneficial than the greatest possible number of cores.

On the other hand, the software used to render models and animations – in other words, to produce the finished article – is among the most multithreaded you can find, so the more cores the merrier. Since processors with a greater number of cores are generally clocked more conservatively than those with fewer, modelling and rendering benefit from different types of processor.

While a fast professional graphics card is a boon for modelling, not all rendering software can harness the power available. In other words, there's no need to spend extra on expensive graphics unless you use software that can take full advantage of it. In this case, there's a further choice to make, between the types of GPU acceleration available. Only Nvidia's cards offer CUDA acceleration, while both Nvidia and AMD accelerate OpenCL (see *The workstation graphics question*, p82).

In practice, the systems in a small 3D-content-creation company or independent artist's studio will need to be able to handle modelling and rendering. Only larger companies can afford to set up machines dedicated to each task: a dedicated farm of servers for rendering, and



workstations for modelling. We have examples of both approaches in this month's Labs. While Armari's Magnetar M18H-AW1200 aims to be the jack-of-all-trades (and master of most as well), the Scan 3XS GW-HT15 is brilliant for modelling, and merely very good for rendering.

■ Photo and video editing

Photo editing benefits from a fast processor and plenty of RAM, but doesn't usually gain much from multiple cores or a high-end graphics card. However, some software – including the DxO OpticsPro 10 application we used for testing – can be accelerated via CUDA or OpenCL.

Video editing may gain from multiple cores as well as clock speed, but the software you use will dictate whether the graphics card is of any benefit. Sony Vegas supports OpenCL, and Adobe Premiere Pro's Mercury Playback Engine can benefit from Nvidia's CUDA acceleration. Keep in mind that the benefits of this acceleration apply only to certain activities, not across the board. Perhaps a more important consideration with video is the huge amount of hard disk space the files occupy. And, with data rates for 4K footage pushing past the 100Mbps/sec mark even when the video is compressed, the disks need to be as fast as possible too.

1 Workstations specialising in 3D rendering commonly sport two CPUs, since the software works best with as many cores as possible

2 Professional-level graphics cards are expensive, but necessary if you're working with high-end engineering or 3D modelling applications

3 The big-name brands are more likely than smaller companies to offer chassis designs with tool-free features. The blue tabs inside this Dell allow you to replace the hard disks, power supply and graphics card without a screwdriver

■ Maintenance concerns

Of course, it isn't all about performance. In this Labs we've evenly divided our selection between UK workstation manufacturers Armari, Scan and Workstation Specialists, and mainstream big brands Apple, Lenovo, Dell and HP. The latter are more likely to offer clever chassis designs that are easier to upgrade and maintain, or that are smaller, quieter and easier to live with than a large unwieldy box.

Above all, bear in mind that workflow fluidity can have a huge impact on the economic viability of your business, and a fast, reliable workstation tailored to your specific needs can make all the difference. Read on to find out which workstation best suits your needs.

How we test

In order to give the broadest possible workstation advice, we've used a wide variety of software for testing. Our Real World Benchmarks suite assesses the general speed at which the system runs Windows, how good it is at running more than one application simultaneously, and how it runs a selection of common media tasks including video and 3D rendering.

In addition to this, we run tests specifically aimed at higher-end workstation activities. To test 3D modelling, we use SPECviewperf 12, which runs a number of tests representing graphics content and real-world behaviour from a number of popular 3D, engineering and medical applications. Maxon Cinebench R15 contains another OpenGL modelling test, alongside a highly multithreaded 3D-rendering test, which benefits greatly from multiple processor cores. We also test GPU-accelerated 3D rendering with the Nvidia CUDA-orientated Bunkspeed Shot and OpenCL-powered LuxMark 2.

We test the raw performance of the storage subsystem with ATTO's Disk Benchmark. Image-editing performance is assessed using DxO OpticsPro 10 running a gruelling noise-reduction process across multiple raw images. Video editing is tested using our standard Sony Vegas test, but with 4K video files instead of HD.

In the case of the Apple Mac Pro, which doesn't run Windows out of the box, we ran every test we could using OS X, including Maxon Cinebench R15, LuxMark 2 and DxO OpticsPro 10. The remainder of our test suite was run on Windows 8.1 under Boot Camp.



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The workstation graphics question

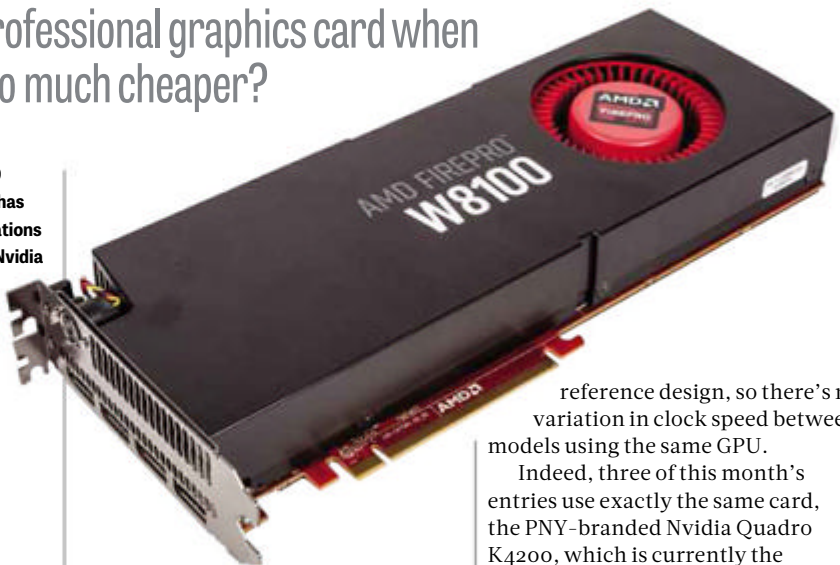
Why do manufacturers choose a professional graphics card when consumer-grade equivalents are so much cheaper?

Not all of this month's workstations incorporate Intel's professionally orientated Xeon processors, and those that don't gain considerably from the Core i7's more flexible clock speed. But every single system in this Labs has opted for professional-grade graphics.

If you follow the 3D graphics business, you'll be aware that, while professional and consumer CPUs are quite different these days, most professional graphics cards have a fairly close equivalent in the consumer range.

With professional graphics usually costing at least twice as much as the consumer-grade alternative, it would seem an obvious economy to opt for consumer-grade graphics as well as a consumer-grade CPU. But few manufacturers do this, and certainly none of the manufacturers featured in this month's Labs. Why is this?

RIGHT The AMD FirePro W8100 has similar specifications to the high-end Nvidia Quadro K5200, but is cheaper



BELOW The Mac Pro is one of only two workstations this month with AMD graphics cards

■ Warranty and certification

Manufacturers often quote "workstation optimisation" to justify the price difference between consumer and professional graphics cards. Products in the AMD FirePro and Nvidia Quadro ranges come with longer warranties – usually three years instead of two, or even one. The cards are also tested with a wide range of professional applications, and come with certifications of compatibility with common design and engineering software.

This in turn means that, in theory at least, the hardware vendor will be able to provide technical support and bug fixes to ensure you get your chosen application working as it should, which is fundamentally important when you're on a deadline.

There's greater deviation between consumer and professional cards as you move up the Quadro and FirePro ranges. Each is topped by models with huge memory allocations: the AMD FirePro W9100 with a whopping 16GB of GDDR5, and the Nvidia Quadro K6000 with 12GB of GDDR5. No consumer card can match that. In fact, these cards are aimed at different markets to the products further down the range – for example, engineering and medical imaging, which requires huge texture sets. However, you do pay for the privilege: the former card costing more than £2,500, and the latter £3,000 plus.

■ The usual contenders

The focus on professional graphics in workstations means that there aren't many options available. Professional cards follow the manufacturers'

reference design, so there's no variation in clock speed between models using the same GPU.

Indeed, three of this month's entries use exactly the same card, the PNY-branded Nvidia Quadro K4200, which is currently the mainstream power choice. This has 1,344 CUDA cores and 4GB of 5.4GHz GDDR5 memory. Only Lenovo has opted for the lower-end Quadro K2200, which still has 4GB of GDDR5, but clocked at a slower 5GHz, and with only 640 CUDA cores. Dell has ventured in the opposite direction and chosen the higher-end K5200, which doubles the memory complement to 8GB of GDDR5, running at 6GHz, and ups the core count to 2,304, promising hugely impressive 3D performance.

Only Armari and Apple have deviated from the Nvidia norm. Armari has opted for a pair of AMD FirePro W8100 GPUs: each has a specification on a par with the higher-end K5200, but a price closer to the K4200. It offers the same 8GB of GDDR5 as the K5200, running at a slightly slower 5.5GHz, with 2,560 stream processors. Note, however, that the latter figure isn't directly comparable to CUDA cores due to the difference in architectures.

The Apple Mac Pro also comes with twin AMD graphics cards, in this case D700s, each with 2,048 stream processors and 6GB of 5.5GHz GDDR5. Although the Nvidia Quadro range has become more popular recently for professional workstations, AMD cards still have plenty to offer, and for some applications can be the better choice.

■ 3D graphics as coprocessor

Separate to the issue of professional versus consumer graphics, the GPU has morphed over the past few years from a single-purpose 3D accelerator to a much more general coprocessor. GPU power became more generic





with the advent of the unified shader model in 2006, which opened up the possibility for what is sometimes called GPGPU – general-purpose computing on graphics processing units.

In short, any software task that involves massively parallel calculations can benefit from the processing power of a GPU. Scientific and financial modelling are potential recipients of these benefits, as is offline 3D rendering using ray tracing; an increasing number of applications in other areas are also now building in support.

Unfortunately, in a situation that reflects the fierce competition between Nvidia and AMD, the two companies have taken radically different strategies towards implementing GPGPU acceleration. Nvidia's preferred method is CUDA, a proprietary technology that it doesn't license to other hardware companies, so AMD graphics cards aren't compatible. Software must be written specifically to support CUDA, such as the Bunkspeed Shot software we've used for testing, or Adobe's Mercury Playback Engine.

AMD, meanwhile, has put its weight behind OpenCL. This is intended to be an open standard for GPGPU acceleration, in the same way that OpenGL is for graphics. Both AMD and Nvidia graphics cards provide hardware OpenCL acceleration, and you can install drivers so Intel and AMD processors support it too. The LuxMark 2 OpenCL rendering test we used this month can be run on GPU, CPU or both. Sony's Vegas Pro has OpenCL acceleration as well as CUDA support.

In reality, there's a blur between CUDA and OpenCL. Many of Adobe's

ABOVE Adobe's Mercury Playback Engine, as used in Premiere Pro CC, includes some CUDA-accelerated effects

applications have CUDA support for a range of features, but not OpenCL. Autodesk Maya, on the other hand, harnesses CUDA for greater scene complexity, but empowers its physics simulations with OpenCL. Avid sides with CUDA, but Blackmagic's popular DaVinci Resolve video-grading

application can utilise either. And while the Foundry's Nuke and Mari video-compositing software is exclusively accelerated by CUDA, Apple's Final Cut Pro X relies on OpenCL.

"There's still much more potential to be tapped from GPGPU, with current software only scratching the surface"

■ CUDA or OpenCL?

BELOW Apple's Final Cut Pro X is OpenCL-accelerated, so AMD hardware will provide the most benefit

There's still much more potential to be tapped from GPGPU, with current software only scratching the surface of what's possible. To gain the most benefit, however, it's

clear you need to take into account the software you plan to use, and how well it is optimised for each of the two vendors.

Since Nvidia Quadro GPUs support OpenCL as well as CUDA, they would seem like the obvious choice for maximum flexibility. However, as our tests this month have shown, AMD's FirePro cards are significantly more efficient with OpenCL. You'll need an Nvidia Quadro to make the most of CUDA software, and they're also the best option for software that uses both platforms – but any software using OpenCL extensively will run better with a FirePro.

It may even be cost-effective to have a secondary GPGPU device dedicated to CUDA or OpenCL acceleration. Nvidia has created a range of cards specifically for this purpose called Tesla, while AMD has its Stream range. However, any additional graphics cards can be harnessed alongside the main one for GPGPU activities. Although graphics card companies would like you to buy their expensive professional models, consumer-grade graphics have become popular in this role, since software compatibility is less of an issue.

We don't have any examples of this trend this month, although Armari's Magnetar M18H-AW1200 and Apple's Mac Pro both include pairs of AMD FirePro cards, with the second card targeting OpenCL.

Despite that, and the huge potential of the technology, GPGPU currently remains rather niche, evidence of which can be seen in this month's group of workstation machines: the majority have only single Nvidia Quadro graphics cards inside.



Overall	Apple Mac Pro (late 2013)	LABS WINNER	Dell Precision T7810	HP Z640	Lenovo ThinkStation P500	RECOMMENDED	Workstation Specialists WS-X140	Workstation Specialists RS-D
Information								
Price (inc VAT)	£4,616 (£5,539)	£5,495 (£6,594)	£4,130 (£4,957)	£5,700 (£6,840)	£1,443 (£1,732)	£1,799 (£2,159)	£1,990 (£2,388)	£3,915 (£4,698)
Manufacturer	apple.com/uk	armari.co.uk	dell.co.uk	hp.com/uk	lenovo.com/uk	scan.co.uk	workstationspecialist.com	workstationspecialist.com
Delivery	Free	Free	Free	Free	Free	Free	Free	Free
Warranty	1yr RTB	3yr (1yr on-site, 2yr RTB parts and labour)	3yr RTB	3yr on-site	3yr on-site NBD	3yr (1yr on-site, 2yr RTB parts and labour)	3yr RTB	3yr RTB
Core components								
Processor (max clock speed)	3GHz Intel Xeon E5-1680 v2 (3.9GHz)	2.6GHz Intel Xeon E5-2697 v3 (3.6GHz)	2x 2.3GHz Intel Xeon E5-2650 v3 (3GHz)	2x 3.2GHz Intel Xeon E5-2667 v3 (3.6GHz)	3.5GHz Intel Xeon E5-1620 v3 (3.6GHz)	3.3GHz Intel Core i7-5820K overclocked to 4.4GHz	4GHz Intel Core i7-4790K overclocked to 4.4GHz	2x 2.8GHz Intel Xeon E5-2680 v2 (3.6GHz)
Total cores/threads	8/16	14/28	20/40	16/32	4/8	6/12	4/8	20/40
Expansion slots (number free for expansion)	4x RAM slots (0); 2x PCI-E x16 (0)	8x RAM slots (4); 7x PCI-E x16 (5); 12x SATA 600 (11)	8x RAM slots (4); 2x PCI-E x16 (1); PCI-E x8 (1); PCI-E x4 (1); PCI-E x1 (1); PCI (0); 6x SATA 600 (3)	8x RAM slots (0); 2x PCI-E x16 (1); PCI-E x8 (1); PCI-E x4 (0); PCI-E x1 (1); PCI (1); 6x SATA 600 (4)	8x RAM slots (4); 2x PCI-E x16 (1); 2x PCI-E x4 (2); PCI-E x1 (1); PCI (1); 6x SATA 600 (4)	8x RAM slots (4); 5x PCI-E x16 (4); 10x SATA 600 (8)	4x RAM slots (0); 4x PCI-E x16 (3); PCI-E x4 (1); 2x PCI-E x1 (2); 8x SATA 600 (6)	16x RAM slots (8); PCI-E x16 (1); 2x SATA 3 (0); 6x SATA 2 (6)
RAM fitted, type and speed	32GB, DDR3 1866MHz	64GB, DDR4 2133MHz	32GB, DDR4 2133MHz	64GB, DDR4 2133MHz	16GB, DDR4 2133MHz	16GB, DDR4 2,666MHz	32GB, DDR3 1,600MHz	64GB, DDR3 1866MHz
Graphics card (RAM)	2x AMD FirePro D700 (6GB GDDR5, 5.5GHz)	2x Sapphire AMD FirePro W8100 (8GB GDDR5, 5.5GHz)	PNY Quadro K5200 (8GB GDDR5, 6GHz)	PNY Quadro K4200 (4GB GDDR5, 5.4GHz)	PNY Quadro K2200 (4GB GDDR5, 5GHz)	PNY Quadro K4200 (4GB GDDR5, 5.4GHz)	PNY Quadro K4200 (4GB GDDR5, 5.4GHz)	Aspeed AST2300 (16MB)
Video outputs	HDMI; 6x Thunderbolt 2	4x DisplayPort 1.2	2x DisplayPort 1.2; 2x DVI-D DL	2x DisplayPort 1.2; DVI-D DL	2x DisplayPort 1.2; DVI-D DL	2x DisplayPort 1.2; DVI-D DL	2x DisplayPort 1.2; DVI-D DL	VGA
Drives								
SSD (connection type)	512GB Samsung XP941 (PCI-E M.2)	512GB Samsung XP941 (PCI-E M.2)	250GB Samsung 840 Evo (SATA 600)	512GB Micron M550 (SATA 600)	240GB Intel SSD Pro 1500 Series (SATA 600)	256GB Samsung 850 Pro (SATA 600)	250GB Samsung 840 Evo (SATA 600)	120GB Samsung 840 Evo (SATA 600)
Hard disk	N/A	4TB WD Se Enterprise (7,200rpm, 64MB)	1TB WD WD10EZEX (7,200rpm, 64MB)	300GB Seagate Cheetah 15K.7 (15,000rpm, 16MB)	N/A	2TB Seagate Barracuda 7200.14 (7,200rpm, 64MB)	1TB Seagate Barracuda 7200.14 (7,200rpm, 64MB)	N/A
Optical drive	x	Blu-ray writer	DVD writer	DVD writer	DVD writer	DVD writer	DVD writer	DVD writer
Case & connections								
Model (dimensions WD/H)	Apple Mac Pro (167x167x291mm)	Armari M75-S4HS (220x445x430mm)	Dell Precision T7810 (173x472x414mm)	HP Z640 (175x465x445mm)	Lenovo ThinkStation P500 (175x470x440mm)	Corsair Carbide 330R (210x495x484mm)	Workstation Specialists (219x533x94mm)	Workstation Specialists (219x533x94mm)
PSU make and model (power output)	Apple (450W)	Intel (1,200W)	Dell H825EF-02 (825W)	HP D12-925PIA (925W)	Lite-On (650W)	Corsair RM (550W)	FSP (unspecified)	FSP FSP500-701UH (500W)
Rear ports ¹	2A; 2G; 1H; 6T2; 4U3	5A; 2DP; 2E; 2G; 1S; 2T2; 10U3	2A; 1G; 2PS/2; 3U2; 3U3; serial	2A; 1G; 2PS/2; 1SR; 2U2; 4U3	3A; 1G; 1S; 2U2; 8U3 serial	5A; 1G; 1S; 2U2; 8U3	6A; 1DP; 1E; 2G; 1H; 1MDP; 1S; 2U2; 6U3	3G; serial; 2U2; VGA
Front/top ports	None	2A; 2U2; 2U3	2A; 3U2; 1U3	2A; 4U3	1A; 4U3; SD slot	2A; 4U3; card reader	2A; 2U3	1U2
Software								
Operating system	OS X 10.10	Windows 8.1 64-bit	Windows 7 64-bit	Windows 8.1 64-bit	Windows 7 64-bit	Windows 7 64-bit	Windows 7 64-bit	Windows 7 64-bit
Company information								
Main location	Cork, Ireland	Watford, Hertfordshire	Bracknell, Berkshire	Bracknell, Berkshire	Hook, Hampshire	Bolton, Lancashire	Derby, Derbyshire	Derby, Derbyshire
Number of permanent sales/support staff	Not stated	3 x sales; 3 x support	Not stated	Not stated	130 x sales; 200+ x support	25+ x sales; 5 x 3XS support	12 x sales; 11 x support	12 x sales; 11 x support

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Armari Magnetar M18H-AW1200

A 14-core Intel Xeon, dual AMD graphics, plenty of RAM and a great chassis make this a superb all-rounder

SCORE ★★★★★

PRICE £5,495 (£6,594 inc VAT) from armari.co.uk (pcpro.link/247armari)

Armari is a homegrown workstation company with a few decades of experience of producing cutting-edge workstations. But unlike many other UK brands, Armari designs its own chassis, one of which is employed here.

The Magnetar M18H-AW1200 uses a custom Armari M75-S4HS case, with a number of features normally associated only with blue-chip vendors, such as the option for dual-redundant power supplies and hot-swap hard disks. The chassis is also exceedingly well-constructed, and has a clever pop-up carry-handle on top to help with transportation.

High-power specifications

Armari has unapologetically targeted the high end with the M18H-AW1200's specification, but in a non-traditional way. Instead of going for the usual dual-socket approach favoured by machines at the

top end of the workstation market, Armari has opted for a single CPU. Since the top Xeon models can have up to 18 physical cores, there's often no need to have more than one CPU.

To keep costs under control, however, Armari has chosen to

ABOVE Unusually, Armari has designed its own case for the Magnetar M18H-AW1200

supply a 14-core Xeon E5-2697 v3. This runs at a native 2.6GHz but has a 3.6GHz Turbo Boost, so it should still offer good capabilities for applications that require clock speed more than core count. With Hyper-Threading available, this single CPU can offer a huge 28 virtual cores for parallel tasks such as rendering.

The Xeon also supports DDR4 memory, and Armari has supplied the M18H-AW1200 with 64GB of 2,133MHz RAM, which may well be ample for the lifetime of the machine. All the same, this is provided in four modules, leaving four slots free, so there's still room to upgrade to the 128GB maximum supported by the X99 chipset on the Asus X99-E WS motherboard.

Armari has also taken advantage of the Thunderbolt header on the board by adding a companion ThunderboltEX II/DUAL add-on card. This provides two DisplayPort inputs and a pair of 20Gbits/sec Thunderbolt 2 ports, for ultra-high-speed external connectivity.

Graphics – a novel approach

Armari has taken another unusual approach by supplying a pair of graphics cards, in the shape of twin AMD FirePro W8100s. The reason the



LEFT The chassis allows you to add storage without even opening the case

1 One CPU is better than two: Armari takes the middle road with its Magnetar, specifying a single CPU, but one with many more cores than the dual-CPU machines on test

2 The twin W8100 graphics cards sit at the very top of AMD's FirePro range, and offer excellent OpenCL GPU acceleration while costing around half as much as Nvidia's equivalent cards

3 The extra width of the Magnetar's chassis allows for a selection of unusual features. Behind the motherboard at the rear, for example, is a pair of 3.5in bays that allows extra storage to be added without even opening up the case (see below left)

4 Armari has included an Asus ThunderboltEX II/DUAL in the build, a PCI Express card that adds a pair of Thunderbolt 2 ports and two full-sized DisplayPort inputs to the Magnetar's already impressive range of connections



company has followed this strategy – to optimise for OpenCL coprocessing as well as graphics performance – is that the W8100 is about half the price of the equivalent Nvidia Quadro K5200, and superior with OpenCL.

Yet another novel component is the 512GB Samsung XP941 M.2 SSD, which connects via the PCI Express bus. The Apple Mac Pro is the only other here to use the same connection, although a number of the other workstations support it. Our ATTO tests showed this hitting almost 900MB/sec read speeds and over 1GB/sec writes – far faster than standard SATA-based storage.

Armari has partnered the SSD with a 4TB WD Se 7,200rpm hard disk. This isn't the quickest unit we've seen, but capacity is generous, so it will be great for data-hungry applications such as video editing.

■ A case for professionals

Beyond the specification, what marks out the Magnetar from our other homegrown contenders is the chassis design, which puts it in a

similar league to the blue-chip vendors. The 1,200W power supply easily slides out at the rear, and there's a second bay above. With a 1,600W option alongside dual redundancy, plenty of fail-safe power is readily available.

Just above the PSU bays at the rear, two hot-swap 3.5in drive bays mean you can add storage without even having to open up the case. Two further internal 3.5in bays are hidden behind a side panel, but are easy to access once you find them. And only one of these is occupied, since the SSD is attached directly to the motherboard.

■ Performance

Across most of our tests, the Armari acquitted itself well. It was top in our Real World Benchmarks, with a score of 1.61, thanks to an excellent showing in the Media tests. It came third in the Maxon Cinebench R15 render test with 2,173, but only to HP's more expensive dual-socket entry and the Workstation Specialists RS-D render node.

Its modelling abilities are highly commendable too, with the joint-best score of 64fps in SPECviewperf's Maya test, a decent showing of 78fps in the SolidWorks test, and good results elsewhere, including 160fps in the Cinebench OpenGL test, which only the modelling-focused, overclocked Core i7 systems from Scan and Workstation Specialists could beat.

In the Sony Vegas 4K video export, the Magnetar also came out on top; it was second in the DxO OpticsPro raw-file processing test; and it blew most of the competition out of the water in the LuxMark 2 OpenCL benchmark, achieving a score of 5,188 overall. In the latter test, only Apple's similarly AMD-equipped Mac Pro came close.

While this is an expensive system, it's a great all-rounder, and an easy match for any workstation task you could throw at it. This, alongside the great design of the chassis, makes the Armari Magnetar M18H-AW1200 our overall winner this month.



Workstation Specialists WS-X140 and RS-D

A dual-purpose setup that provides separate systems for modelling and rendering

SCORE ★★★★★

PRICE WS-X140, £1,990 (£2,388 inc VAT); RS-D, £3,915 (£4,698 inc VAT) from workstationspecialist.com (pcpro.link/247wsx140 and pcpro.link/247wsrsd)

Workstation Specialists has taken a rather different approach for its entry this month. This is a 3D-animation-focused system, but rather than targeting either the modelling or rendering part of the workflow, or attempting to be a jack-of-all-trades, the company has chosen to adopt a dual-pronged approach to the two tasks. The main WS-X140 workstation is aimed at modelling, and a smaller secondary unit – the RS-D – is supplied specifically for rendering, and is designed to sit on top.

■ Many hands make light work

The idea is that rendering jobs can be farmed off over the network to the RS-D, so modelling work can continue uninterrupted.

In fact, a single RS-D unit could be shared by multiple workstations,

which could save a small studio a lot of money. The WS-X140 supplied in this bundle is a case in point. It takes the now common approach of using an Intel Core i7 processor

permanently clocked to a higher setting than stock. In this case, it's an i7-4790K, which is rated at 4GHz but has been set permanently to its 4.4GHz Turbo Boost frequency across all cores. As with other manufacturers taking this approach, the CPU has been fully tested and guaranteed for this speed by the company for the full three years of the warranty.

The Core i7-4790K is from the Intel Haswell

ABOVE A smaller secondary unit designed specifically for rendering sits on top of the workstation

generation released in the first half of 2014, so supports only DDR3 memory, but it has at least been partnered with a healthy 32GB of the 1,600MHz variety. This is supplied in the shape of four DIMMs, so there are no slots free for future upgrades.

The i7-4790K is a quad-core processor, so it presents eight virtual cores to Windows through Hyper-Threading. It has decent rendering abilities, but 3D modelling is really this system's forte, and for that a

capable PNY-branded Nvidia Quadro K4200 graphics card has been supplied.

For storage, there's a SATA-connected SSD for the OS and applications, with a conventional

hard disk for content. The former is a 250GB Samsung 840 Evo, while the latter is a 1TB Seagate Barracuda 7200.14. Both are adequate for their purpose, but not exactly generous at this price.

Like UK-based suppliers, Workstation Specialists uses an off-the-shelf chassis. This means that you'll need a screwdriver to swap parts. The RS-D render node will also require unscrewing to open,

"A single RS-D unit could be shared by multiple workstations, which could save a lot of money in a small studio"

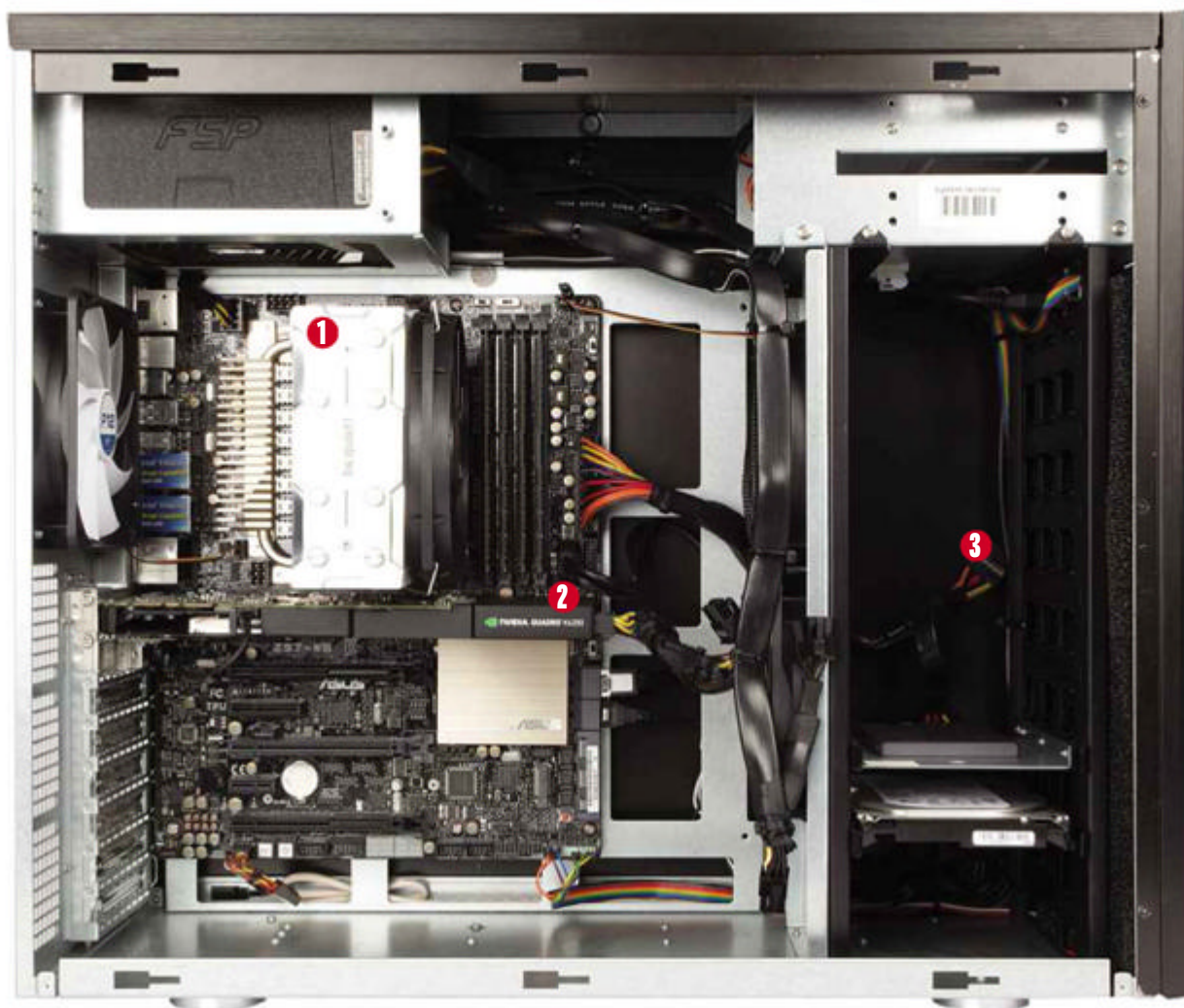
LEFT You need a screwdriver to get into the off-the-shelf chassis



1 The larger desktop box sports only a single CPU. In this case, it's an Intel Core i7-4790K, overclocked to 4.4GHz. All the heavy rendering is done in the background by the rendering node (see opposite), which features a pair of ten-core 2.8GHz Intel Xeon E5-2680 v2 CPUs

2 The WS-X140's graphics card is an Nvidia Quadro K4200. It isn't the top of the range, but represents a good balance of cost and performance, and supports both CUDA and OpenCL GPGPU acceleration

3 The case is large and has plenty of room for upgrades, with a big, vertical cage at the front providing enough space for a stack of 3.5in hard disks



and most components are quite difficult to get to without taking the unit apart completely.

Render specific

The secondary RS-D follows a very different strategy to the WS-X140, focusing on core count rather than clock speed.

To this end, it incorporates a pair of Intel Xeon E5-2680 v2 processors, each with ten cores, bringing the total with Hyper-Threading to 40 virtual cores. This makes it ideal for 3D rendering, and Workstation Specialists has also included a sizeable 64GB of 1,866MHz DDR3 memory. Storage is provided by another Samsung 840 Evo SSD with a low 120GB capacity; since you won't need to install full applications on this – only network rendering agents – this should be fine.

This system won't be any use for modelling, though. The Aspeed AST2300 integrated graphics offers only 16MB of memory, has no 3D acceleration, and sports only a single VGA output. It's really only

there for setup, after which you manage and access the RS-D over the network "headless", via remote desktop. And although there's a PCI Express x16 slot available, this uses a riser to flip the orientation by 90 degrees, and has space for only half-height cards. In short, the RS-D would never be able to offer high-level modelling abilities; it's very much a dedicated render node.

Performance results

Since it comprises two systems, Workstation Specialists' offering provides two very different sets of benchmark results.

The WS-X140 achieved the second-highest Maxon Cinebench OpenGL result this month, of 174fps, and its SPECviewperf 12 results were also excellent, including the joint-highest score in the SolidWorks test this month of 102fps, and the third-highest Maya score of 56fps.

Our Real World Benchmark scores were more mediocre, though, at 1.32 overall, as were the DxO OpticsPro result of 56 seconds and

the 2mins 17secs Sony Vegas video render. The only benchmark score that's worth mentioning for the RS-D is its Cinebench rendering result of 2,643, which is the fastest on test, although the HP's 16-core Z640 isn't far behind.

Verdict

Overall, the novel approach taken by Workstation Specialists has a lot going for it. Costing only around £500 more than Armari's Magnetar M18H-AW1200 for both parts, it offers superior rendering – unless you're using OpenCL – and similarly strong modelling abilities

that you can use while your rendering takes place in the background.

However, for activities such as video and photo editing, you can't use the RS-D, so this combination isn't so handy. It's a great workstation combo for small studios creating 3D content, but other professionals will want to look for a more flexible, one-box alternative.

"Since it comprises two systems, Workstation Specialists' offering provides two very different sets of benchmark results"



Apple Mac Pro (late 2013)

A beautiful piece of engineering from Apple, and brilliant for some uses – but very expensive

SCORE ★★★★★

PRICE £4,616 (£5,539 inc VAT) from [apple.com/uk\(pcpro.link/247macpro\)](http://apple.com/uk(pcpro.link/247macpro))

It's easy to fall in love with the Apple Mac Pro's dinky cylindrical chassis, which will sit happily next to your monitor without spoiling your working environment. Yet its attractive exterior hides a surprisingly powerful set of components: it can be specified up to a 12-core Intel Xeon processor, 64GB of RAM, 1TB of flash storage and dual graphics cards. Our sample was the mid-range eight-core model, using an Intel Xeon E5-1680 v2, offering 16 virtual cores. The native clock speed is 3GHz, and with a top Turbo Boost frequency of 3.9GHz, it's good for raw speed as well as parallel processing.

It's from the Ivy Bridge era, so it supports only DDR3 rather than the latest DDR4 memory, but Apple has supplied 32GB of fast 1,866MHz DIMMs. These occupy all four slots, so there's no room for upgrade.

Graphics provision is exceptional. The Mac Pro incorporates two AMD FirePro D700 graphics cards, each with 6GB of GDDR5 memory running at 5.5GHz and 2,048 stream processors. This is lower in both cases than the AMD FirePro W8100 cards in Armari's offering this month, but the

D700s still offer hefty acceleration for 3D and OpenCL applications. On the downside, the proprietary case means that you can't upgrade them with off-the-shelf cards.

Like the Armari, the Mac Pro opts for PCI Express-connected solid-state storage, with a 512GB drive included. This provides outstanding peak

ABOVE The Mac Pro is incredibly powerful for its size, although it falls behind other workstations here

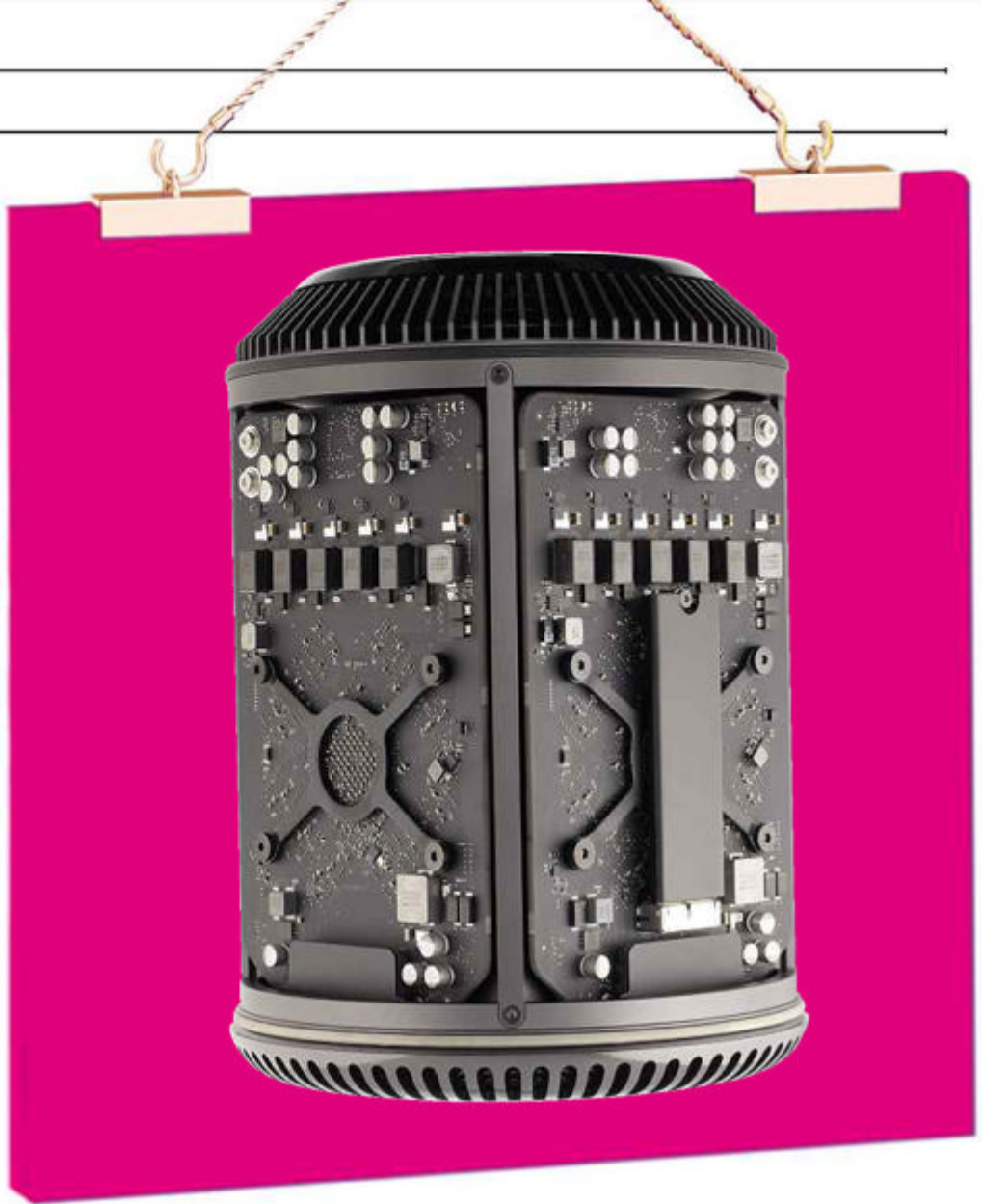
throughput of more than 1GB/sec, but there's no secondary storage option inside. The Mac Pro is intended for use with a Bluetooth keyboard and mouse, so all four USB 3 ports are free. There are six Thunderbolt 2 ports, as well as HDMI, so it isn't lacking expansion in connectivity.

While the Mac Pro is powerful for its size, performance is disappointing. Its Real World Benchmark result of 1.21 sits behind the Scan 3XS GW-HT15 and Workstation Specialists WS-X140, which are both less than half the price.

Its Sony Vegas 4K video export was also mediocre, and while the dual D700 graphics are great for OpenCL, they produced the lowest Maxon Cinebench R15 OpenGL score of 85fps. A strong DxO OpticsPro result of 41 seconds implies that the Mac Pro's forte is 2D design rather than 3D content creation.

In light of these results, the price is hard to justify. For around £1,000 more you could purchase the Armari Magnetar M18H-AW1200, which delivers twice as many processing cores, double the memory, far more storage and faster dual graphics. All the same, the sheer elegance of the Mac Pro makes it impossible to dislike.

LEFT It's easy to fall in love with the elegant cylindrical chassis of the Mac Pro



Dell Precision T7810

A great workstation for engineering, with 40 virtual cores and 32GB of DDR4 RAM

SCORE ★★★★★

PRICE £4,130 (£4,957 inc VAT) from dell.co.uk (pcpro.link/247dellt7810)

The Dell Precision T7810 on test this month is configured primarily for use with engineering software, rather than for content creation. As such, it uses a pair of ten-core Xeon E5-2650 v3 processors, which major on core count rather than frequency: they run at a nominal 2.3GHz, hitting 3GHz in Turbo Boost, but Hyper-Threading yields an enormous 40 virtual cores for parallel-processing tasks.

Dell compensates for the low clock speed by including an Nvidia Quadro K5200. With 8GB of 6GHz GDDR5 memory and 2,304 CUDA cores – 960 more than the K4200 – this is a hugely powerful GPU. The Xeon processor also supports DDR4 memory, and Dell has equipped the T7810 with 32GB of the 2,133MHz variety. The four 8GB DIMMs leave four slots free.

Dell takes the usual two-pronged route when it comes to storage. The SSD supplied for the operating system and applications is a merely adequate SATA-connected 250GB Samsung 840 Evo, and the 1TB WD

Blue 7,200rpm hard disk for general storage is reasonable at this price.

The chassis isn't exactly brimming with extra drive bays, either, with only one 5.25in bay free for upgrades.

And while the case has a spacious layout, with some tool-free component-swapping abilities, the HP Z640 and Lenovo ThinkStation P500 have much more potential for expansion.

The T7810's emphasis on engineering performance leads to a mixed bag of results. Its Overall score of 1.04 in our Real World Benchmarks was the lowest on test, thanks

ABOVE The Dell is aimed specifically at engineers, offering 40 virtual cores for parallel processing

to poor Media and Windows scores. The Maxon Cinebench R15 rendering score of 1,845 was clearly dragged down by the relatively low speed the cores run at when they're all in use. This affected photo and video editing as well, with a rather mediocre result of 52 seconds in DxO OpticsPro and a lacklustre Sony Vegas 4K export.

However, the high-end graphics card gave the Dell an excellent overall result of 18 seconds in the CUDA-powered Bunkspeed Shot render, and 2,364 combined in the LuxMark 2 OpenCL test. The SPECviewperf results were the most telling of all, with a joint-best Maya result of 64fps, and the joint-top score of 102fps in the SolidWorks test. Apart from this and the Autodesk Showcase score, the Dell was the quickest in all the other SPECviewperf 12 viewsets, most of which simulate engineering and medical applications, showing the T7810's strength in these areas.

We can't question the Precision T7810's appropriateness for the intended engineering user, nor for 3D content creation with certain software, including Autodesk Maya. However, this isn't one to consider as a general-purpose workstation.

LEFT The chassis is very well made, although it isn't bursting with extra drive bays





HP Z640

A hugely powerful workstation with an excellent tool-free design – but it's pricey

SCORE ★★★★★

PRICE £5,700 (£6,840 inc VAT) from hp.com/uk (pcpro.link/247hpz640)

HP's Z640 is the second most expensive workstation on test this month, and in many areas the most highly specified. Sporting a pair of Intel Xeon E5-2667 v3 processors, it offers 32 virtual cores with Hyper-Threading enabled, second only to the Dell Precision T7810 and the Workstation Specialists RS-D render node. HP's processors are faster, though, with a nominal frequency of 3.2GHz, boosting to 3.6GHz in Turbo Boost.

Since the Xeon is from the latest Haswell generation, it supports DDR4 memory, and HP has installed 64GB of 2,133MHz DIMMs. Surprisingly, the manufacturer hasn't opted for a top-of-the-range graphics card: the PNY Quadro K4200 is no slouch, but a K5200 would have been a better match for the rest of the specification.

Although PCI Express solid-state storage is an option for the Z640 (HP's "Z Turbo Drive"), this model uses a conventional SATA SSD as primary storage. The 512GB capacity is generous, but performance is way

behind the M.2 drives in the Armari and Apple entries.

Strangely, rather than installing a large 7,200rpm conventional hard disk for data storage, HP has opted for a 15,000rpm SATA disk with only 300GB of capacity. This is the quickest non-SSD on test, but it won't be enough space if you're planning to work with large amounts of video, particularly 4K. However, like other blue-chip vendors here, HP has created a tool-free chassis design that will make it easy to add storage further down the line.

Despite the HP's powerful array of components, it couldn't quite match the performance of Armari's Magnetar in our Real World Benchmarks. Its extra cores gave the HP the upper hand in the

ABOVE The HP Z640 is pricey, but the specification is an odd mix



LEFT The HP's chassis looks understated, but it's brilliantly designed



Multitasking part of the test, but it lagged behind in media creation.

Conversely, the HP's dual eight-core CPU configuration gave it the second-best rendering score in Maxon Cinebench R15, only beaten by the dedicated Workstation Specialists RS-D render node. It achieved the quickest result of 31 seconds in Dxo OpticsPro, and the overall Bunkspeed Shot result of 14 seconds was top of the pack, too. The 4K video export in Sony Vegas took 1min 15secs, putting it in second place.

The HP's Cinebench R15 modelling ability was only a fraction behind that of the Armari, too, with a result of 159fps. Its SPECviewperf 12 results were more varied: the Maya result of 55fps is in the same ballpark as other Quadro K4200-equipped systems, but behind Armari's FirePro W8100 and Dell's K5200. The SolidWorks result of 87fps is similarly in the middle of the pack.

The HP Z640 is a super-powerful workstation, but it's on the pricey side. It's great for tasks such as rendering that can take full advantage of the many cores available, and it would also be great for photo and video editing. However, 3D-modelling abilities with some applications are below what we'd expect at this price, and so it misses out on an award.

Lenovo ThinkStation P500

Couples brilliant chassis design with low-power components to deliver a keenly priced system

SCORE ★★★★★

PRICE £1,443 (£1,732 inc VAT) from lenovo.com/uk (pcpro.link/247lenp500)

IBM farmed off its server brands to Lenovo last year, but thankfully it's been business as usual in terms of quality. The ThinkStation P500 is evidence of this, rivalled only by the HP Z640 for tool-free access. The inside is littered with red flashes showing where to pull to release components, which slide out in a matter of seconds.

Our review sample didn't have the most impressive specifications, however. Its Xeon E5-1620 v3 is the bottom of the new Haswell Xeon E5 range, with a nominal clock speed of 3.5GHz, rising to only 3.6GHz in Turbo Boost. It's a quad-core CPU, so Hyper-Threading provides only eight virtual cores, where the top systems offer 40. There is support for DDR4 memory, though, and there's 16GB of 2,133MHz RAM included, spread across four DIMMs with four slots free.

The graphics card isn't impressive, either. The PNY-branded Nvidia

Quadro K2200 is a capable 3D accelerator, with a sizeable 4GB of GDDR5 memory and 640 CUDA cores. However, it nowhere near as powerful as others in this Labs, some of which offer three times the CUDA cores and twice the memory.

Primary storage is taken care of by a 240GB SATA-connected Intel SSD Pro 1500 Series SSD. This will be adequate for your OS and software, and performance is on a par with other SATA-connected SSDs this month, but it isn't exactly generous. Lenovo didn't include a secondary disk, but there are three easily accessible 3.5in tool-free drive

ABOVE Red flashes show where to pull to release components, making swapping them an easy job

bays empty should you wish to add one yourself.

The P500's entry-level components left it with the second-lowest score in our Real World Benchmarks, with a result of 1.1. Its Maxon Cinebench R15 rendering score of 711 was at the bottom of the table, and only the Apple Mac Pro was slower for the OpenGL preview portion of Cinebench R15.

The Lenovo also posted the slowest score of 1min 17secs in our DxO OpticsPro test, and took 2mins 57secs to output the 4K video in our Sony Vegas benchmark. We couldn't enable GPU acceleration in Bunkspeed Shot, but OpenCL results with LuxMark 2 were reasonable considering the specification. The SPECviewperf 12 results weren't great though, with only the Mac Pro pipping the P500 to bottom place in two of the tests.

It would be unfair to mark the ThinkStation P500 down too much, since most of its rivals this month are far more expensive. The chassis design is excellent, and with the right components it could be very capable. Unfortunately, it's up against some powerful competition in this Labs.

LEFT Unfortunately, the Lenovo's low price is reflected in its entry-level specs



Scan 3XS GW-HT15

A sensible choice of components produces a 3D modelling workstation that's great value for money

SCORE ★★★★★

PRICE £1,799 (£2,159 inc VAT) from scan.co.uk (pcpro.link/247scan3xs)

Of all the workstations on test this month, the Scan 3XS-HT15 is the closest to a regular high-performance desktop PC. It uses an enthusiast-grade Core i7-5820K processor, and comes housed in a Corsair Carbide 330R chassis; this has some great features, but it can't match this month's HP and Lenovo offerings for tool-free access.

Nevertheless, the internals have been chosen to provide strong performance for a keen price. The CPU is from the high-end Haswell-E series, and while it doesn't have the eight cores of the top Extreme Edition, it delivers six cores and a native 3.3GHz clock speed for half the price. Hyper-Threading means the cores are presented as 12 virtual cores, and Scan has clocked the CPU to 4.2GHz, with temperatures kept in check by a 3XS-customised Corsair H100 liquid cooler.

In keeping with the budget, Scan has installed only 16GB of RAM. It's the latest DDR4, however, and it's quick, with a 2,666MHz clock. It comes as four 4GB DIMMs, taking full

advantage of the CPU's quad-channel memory architecture, while leaving four slots free for upgrade.

Scan has also taken the mainstream route when it comes to graphics, with a PNY-branded Nvidia Quadro K4200. This is a great all-round professional

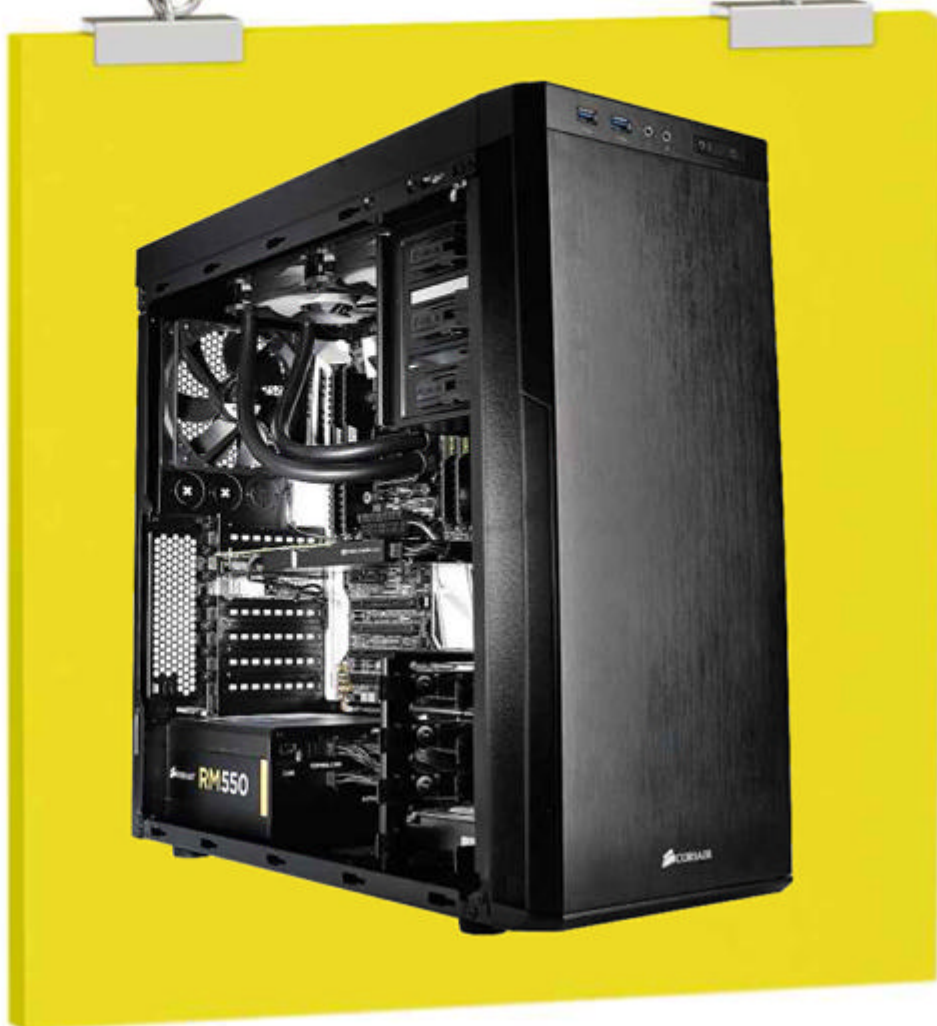
card, providing plenty of horsepower without breaking the budget.

Scan has followed the template of using an SSD for the OS, alongside a regular hard disk for user data. The SSD is a SATA-connected 256GB Samsung 850 Pro, while the hard disk is a 2TB Seagate Barracuda 7200.14 7,200rpm model. SSD performance is

ABOVE The Scan offers plenty of horsepower for the money



LEFT The 3XS uses an off-the-shelf Corsair Carbide 330R chassis



on a par with other SATA SSDs in rival systems, and the hard disk is one of the slower units – but not by a significant margin.

The six-core processor acquitted itself well in our Real World Benchmarks, gaining an Overall score of 1.42. It did particularly well in Multitasking, with 1.57, and in the important Media creation test, with 1.53. Maxon Cinebench R15 rendering also hit a decent score of 1,223.

The GPU-accelerated LuxMark 2 and Bunkspeed Shot render scores were also commendable, with 1,824 in the former and 20 seconds in the latter. The Scan proved a reasonable photo and video editor, too, taking 49 seconds to dispatch our DxO OpticsPro noise reductions, and 1min 36secs to complete our 4K video render. Its real forte was 3D modelling: it achieved 188fps in the Cinebench R15 OpenGL test, and good all-round results in SPECviewperf 12.

At £1,799 exc VAT, the Scan 3XS GW-HT15 provides a lot of power for your money. There are better options if you need a serious rendering station, but its 3D-modelling abilities are unquestionable, and photo- and video-editing performance is strong too. For any of these activities, it's a great-value choice.



Good

Fujitsu Siemens Esprimo E5731

Refurbished Desktop PC, Intel Core2Duo E7500
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with Windows 7 Professional

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View from the Labs

The desktop PC market may be stagnating, but the world of super-powerful workstations has never been more interesting, says **James Morris**

In some areas of the computing world, PCs have become capable enough for most things we want to do with them. But the professional user remains hungry for powerful new technology that will enable more complex work, quicker production times, and the opportunity to realise ever more sophisticated creative ideas in the shortest time possible.

The broad selection of machines in this month's Labs is ample evidence that this sector of the PC market is in rude health. At one end of the spectrum we have the Apple Mac Pro, which packs a huge amount of power into an unfeasibly small and delectably shaped package. At the other, we have the overbuilt chassis of the HP Z640 and the dual-box approach of the Workstation Specialists system.

And where the market for consumer desktop PCs is in the doldrums, there are plenty of interesting developments in the workstation sector.

Chassis design, perhaps influenced by the arrival of the Mac Pro, is undergoing a renaissance, and it isn't only the blue chips involved; others are beginning to up their game, too.



James Morris is a freelance contributor, and a former editor of PC Pro. Email him at reviews@pcpro.co.uk

"The broad selection of machines in this month's Labs is ample evidence that this sector of the PC market is in rude health"

British company Armari, for instance, has designed its own chassis, which almost matches the big boys for build quality and accessibility.

This isn't the only area that's developing apace. After years of domination, the dual-socket workstation is beginning to give way to the more flexible, multi-core, single-socket PC ready to take its place. Now that Xeons are sporting up to 18 cores, the need for more than one processor is fast receding. The 18-core Xeon is prohibitively expensive, and was reportedly designed as a special edition for Google, but the performance of the

single-socket machines this month proves that two CPUs are no longer better than one. The 14-core Xeon E5-2697 v3 in the Armari is a good match for the pair of eight-core CPUs in

the Workstation Specialists RS-D, while being cheaper and requiring about half the power.

The other major trend is one the big manufacturers have yet to join in with: a move towards employing overclocked Core i7 processors instead

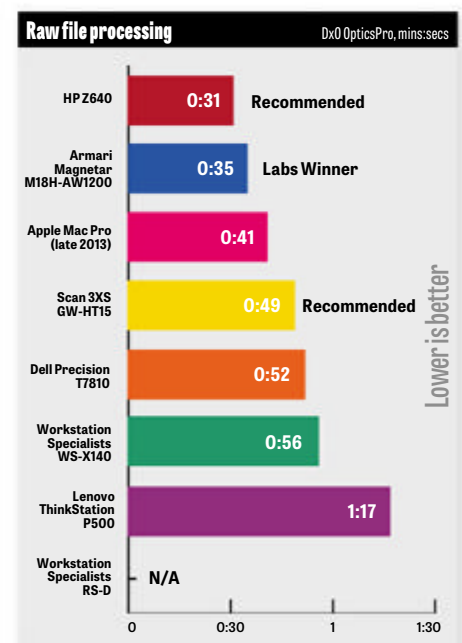
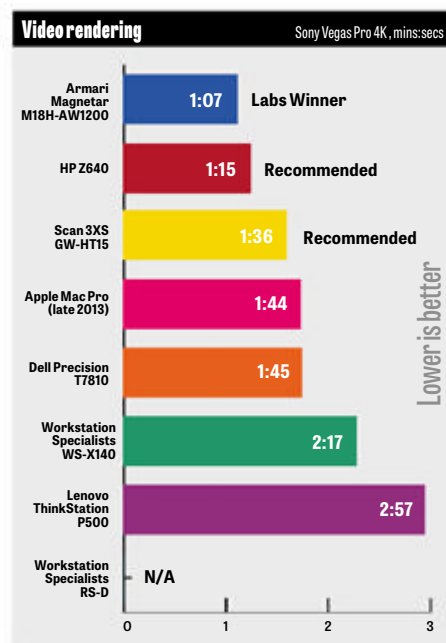
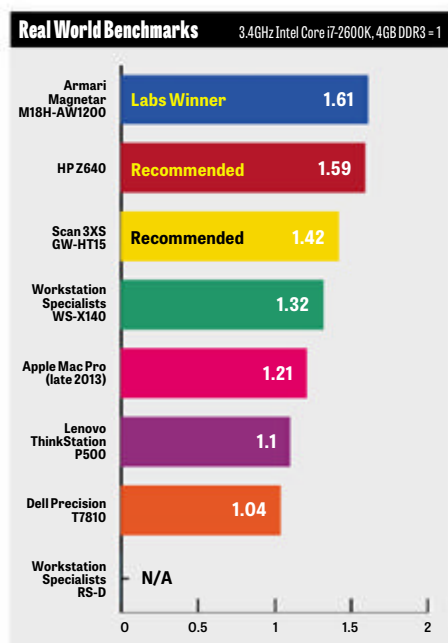
of workstation-specific Xeons. An overclocked Core i7, with potent liquid cooling and a full warranty, is an excellent choice for certain types of workstation activity, particularly modelling, as shown by Workstation Specialists this month.

But although we love the chassis design of HP's Z640 and Lenovo's ThinkStation P500, and the economy of the Scan, our Labs winner is the workstation that combines it all in one competitively priced package. Although, as we highlighted at the beginning of this Labs, it's difficult to master every type of workstation activity at the same time, Armari comes pretty close with the Magnetar M18H-AW1200. ●

Results explained

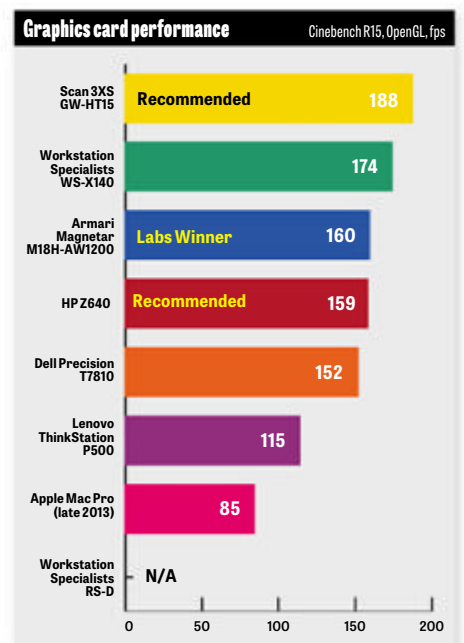
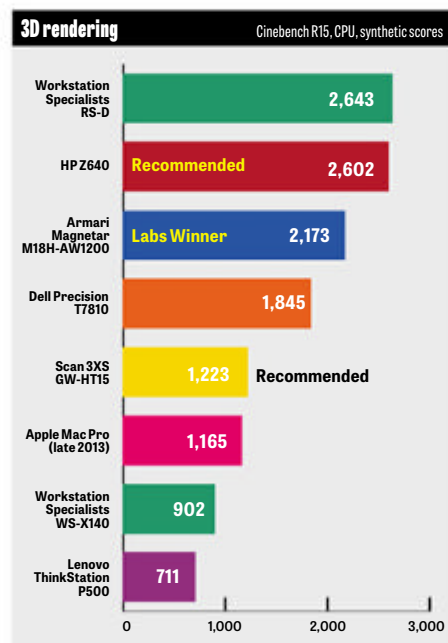
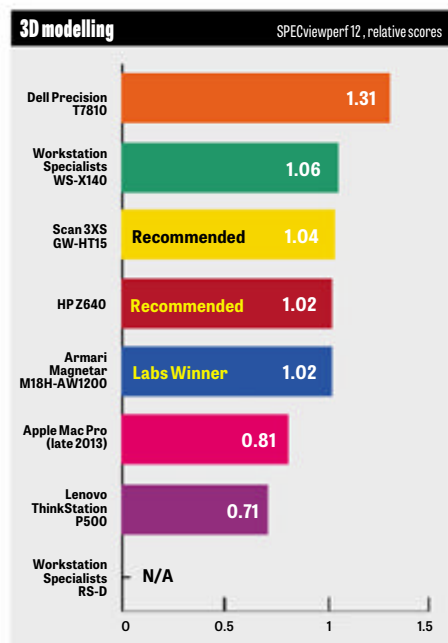
The coloured graphs at the bottom of these two pages provide an at-a-glance overview of how the systems performed. If that's not enough for you, the table to the right delivers a full breakdown of the results each workstation achieved.

Test results



Results in detail

	Apple Mac Pro (late 2013)	Armari Magnetar M18H-AW1200	Dell Precision T7810	HP Z640	Lenovo ThinkStation P500	Scan 3XS GW-HT15	Workstation Specialists WS-X140	Workstation Specialists RS-D
Real World Benchmarks, 3.4GHz Intel Core i7-2600K, 4GB DDR3 = 1								
		LABS WINNER		RECOMMENDED		RECOMMENDED		
Overall	1.21	1.61	1.04	1.59	1.1	1.42	1.32	N/A
Multitasking	1.35	2.05	1.48	2.3	1.1	1.57	1.35	N/A
Windows	0.95	0.99	0.77	0.96	0.99	1.15	1.25	N/A
Media	1.33	1.78	0.86	1.51	1.17	1.53	1.35	N/A
Cinebench R15								
CPU, synthetic score	1,165	2,173	1,845	2,602	711	1,223	902	2,643
OpenGL, fps	85	160	152	159	115	188	174	N/A
SPECviewperf 12, fps								
catia-04 (CATIA)	47	59	87	66	43	67	69	N/A
creo-01 (Creo)	27	44	70	52	36	54	57	N/A
energy-01 (Energy)	3.11	1.97	3.83	3.12	2.83	2.97	2.96	N/A
maya-04 (Maya)	41	64	64	55	37	55	56	N/A
medical-01 (Medical)	22	21	30	21	15	21	21	N/A
showcase-01 (Showcase)	40	56	49	37	22	37	37	N/A
snx-02 (Siemens NX)	52	71	82	63	32	64	64	N/A
sw-03 (SolidWorks)	44	78	102	87	72	98	102	N/A
Bunkspeed Shot, Graffiti Benchmark, seconds								
GPU	N/A	N/A	17	28	Did not finish	28	28	N/A
CPU	56	24	29	20	70	40	59	N/A
Overall	N/A	N/A	18	14	70	20	22	N/A
LuxMark 2 Sala OpenCL								
GPU	3,767	4,253	1,651	960	1,005	952	951	N/A
CPU	1,032	1,528	704	992	567	929	679	1,367
Overall	4,155	5,188	2,364	1,917	1,501	1,824	1,555	N/A
SSD and HDD speed tests (ATTO), MB/sec								
SSD 4K read	128	204	282	88	52	309	332	285
SSD 4K write	119	360	281	157	144	280	296	250
SSD 2048K read	1,011	899	564	530	553	567	554	552
SSD 2048K write	982	1,011	441	455	519	536	533	529
HDD 4K read	N/A	156	101	170	N/A	168	198	N/A
HDD 4K write	N/A	156	98	161	N/A	165	195	N/A
HDD 2048K read	N/A	176	184	208	N/A	177	203	N/A
HDD 2048K write	N/A	164	178	208	N/A	159	199	N/A



The Network



Practical buying and strategic advice for IT managers and decision makers

Business Focus

Which is the best rack server for your business? **p98**

The Business Question

How should small businesses be using encryption? **p106**

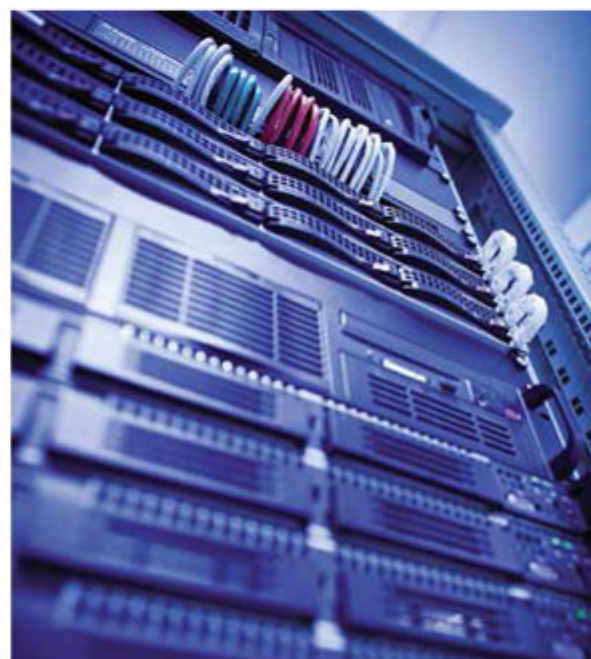
Cheat Sheet

Digitise your company's paper archives **p108**

BUSINESS FOCUS

How to choose your perfect rack server

Dave Mitchell shows what to look for when buying a rack server for your business, and subjects a range of contenders to real-world testing



Whether you're looking for your small business' first dedicated server or just wanting to refresh existing, underpowered systems, the rack server is king. Over the years, such systems have become hugely more capable, and are a great choice for companies wanting to make the most of limited space. When it comes to both processing power and storage, the latest rack servers offer the best densities on the market.

They're also versatile enough to deal with a wide range of duties. Rack servers are more flexible than bulky towers, as they're designed to fit in vertical cabinets that make more efficient use of floor space. Cable, power and server management can be centralised and, as demand increases, you can add more servers to spread the workload.

Which U for you?

Rack servers come in a range of industry-standard vertical measurements called rack units (RU), or just U. A 1U server is 1.75in high, and it's

this measurement, along with its depth, that determines what hardware you can pack into the chassis. For example, Dell's PowerEdge R220 is 1U, but its short depth means there's only room for a pair of internal cold-swap hard disks. Broadberry's 1U CyberServe XE3-R130 is deep enough for four hot-swap 3.5in large-form-factor (LFF) disk carriers.

If high storage density is a key requirement, we recommend 2U models. Both Lenovo's ThinkServer

BELOW When choosing a server, consider the bundled management tools – we include pictures of all of them here, including Lenovo's below

RD440 and HP's ProLiant DL80 Gen9 support 4, 8 or 12 hot-swap LFF hard disks. The RD440 goes a step further: you can order the chassis with 16 small-form-factor (SFF) bays.

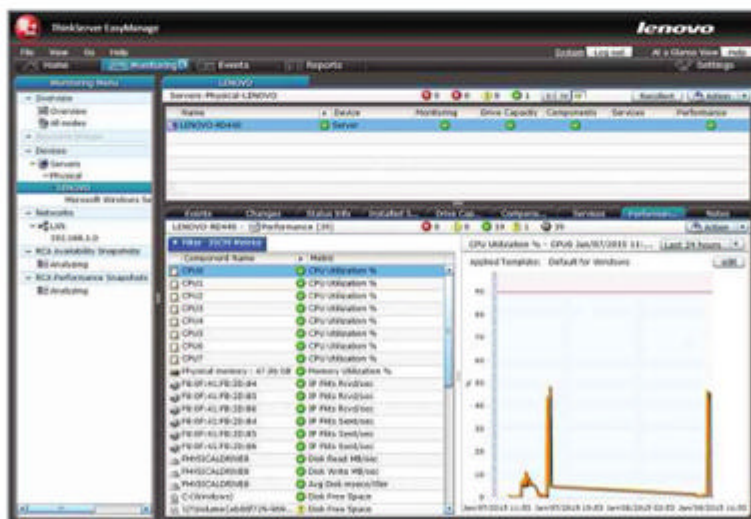
Processor choices

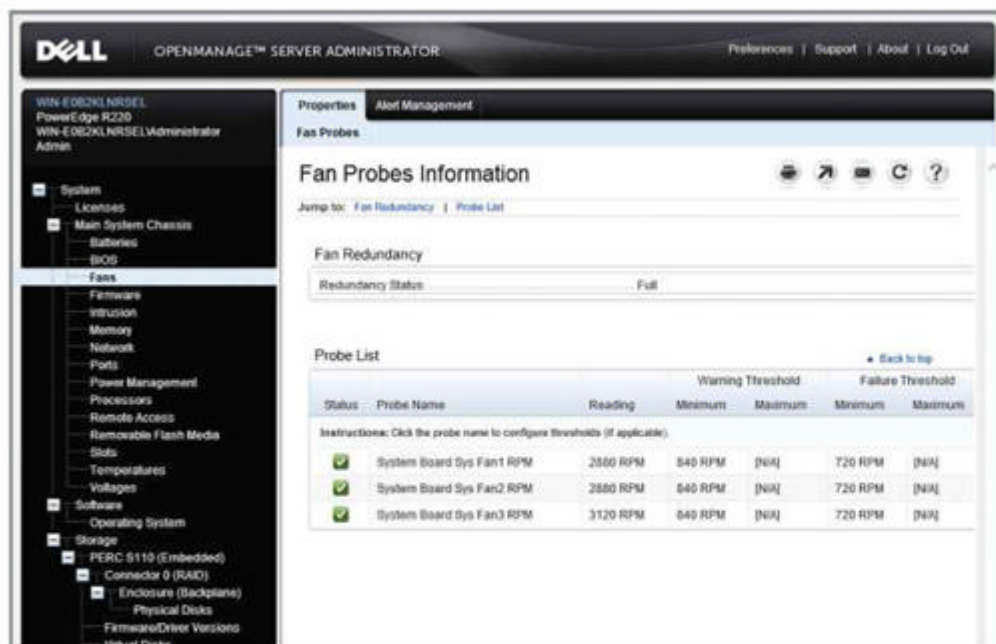
Small businesses will be well served by Intel's Xeon E3-1200 v3 family, which is designed specifically for single-socket, entry-level servers. With speeds of up to 3.7GHz, these chips have

enough power to run typical small-business workloads.

Unlike desktop CPUs, Intel's Xeon range is also packed with server-specific features, including support for error-correcting code (ECC) memory, and for Intel's Turbo Boost 2, which allows the CPU to step up its speed in response to sudden workload spikes. These chips are also a top choice where energy bills are an issue, due to modest power consumption, and their low cost is reflected in the prices of the Dell and Broadberry servers.

As an alternative, while it may be seen as the poor





relative to Intel's Xeon E5-2600, the E5-2400 v2 family, as showcased in the Lenovo RD440, still has much to commend it: dual-socket support, plenty of memory and up to ten cores. This family is also cheaper, as their motherboards cost less to manufacture; the Socket B2 (LGA 1356) package has only one inter-socket QPI link, and support for 12 DIMM slots as opposed to 24.

We hadn't planned on covering E5-2600 v3-equipped servers as Intel's latest mega-core chips were initially on the expensive side. However, HP changed our minds: its DL80 storage-rich 2U rack server brings them within the budgets of SMBs with heavy workloads.

Building up a new home

When buying a cabinet to house your rack servers, think ahead. Standard rack servers fit in cabinets with 19in-wide front- and rear-mounting pillars, but it's the depth you need to pay particular attention to. We once made the mistake of buying an 800mm-deep "data" rack cabinet and found that some of our servers were too deep to fit in it. We recommend at least a 1,000mm-deep "server" rack cabinet if you have space.

You also need to factor in future growth. Make sure the cabinet has free space for additional servers and other network equipment such as switches and patch panels. We installed a 42U-high, 1,000mm-deep rack system six years ago in the lab; so far we haven't had a server that won't

fit in it, and we still have room for more. If space really is at a premium, then consider Dell's R220 server, which will fit easily in a 600mm data cabinet.

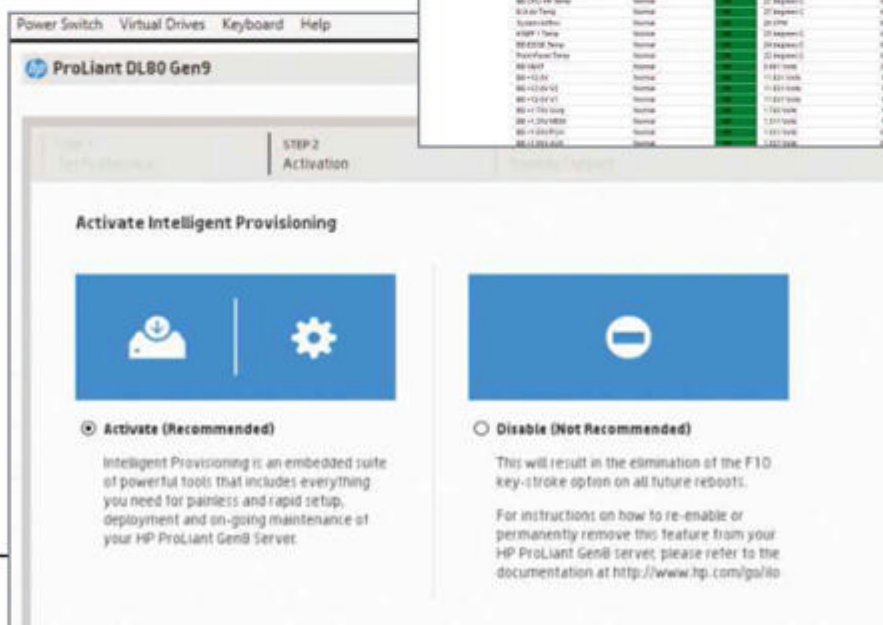
Noise, cooling and power

Older rack servers had a reputation for being noisy, but vastly improved internal airflow design and the latest low-wattage processors have made a huge difference. The Dell R220 we review this month is almost silent, while the HP, Lenovo and Broadberry servers merely whisper.

It's still important to take cooling seriously. Floor-standing cabinets should have fully perforated (and lockable) front and rear doors, and you may want to fit fan trays in the cabinet's roof.

Power is important, too. Make sure there's room for a power-distribution unit (PDU), although zero-U

ABOVE Local PowerEdge server monitoring is provided by Dell's OpenManage Server Administrator web console



ABOVE Broadberry's integrated BMC provides web access for remote monitoring of critical components

LEFT HP's Active Intelligent Provisioning makes OS installation easy

models such as those from APC can slot vertically into the side of the cabinet.

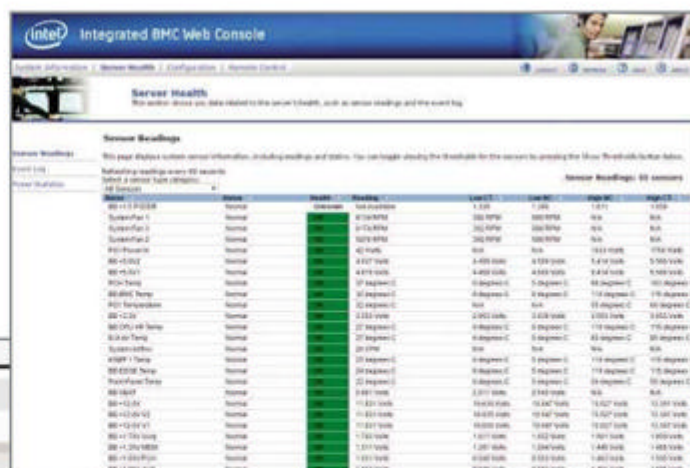
Your rack servers will be running business-critical apps, so protect them further by fitting a rack-optimised UPS (uninterruptible power supply). APC has a handy selector tool on its website to help choose the right one, and we recommend models such as the Smart-UPS family that support optional temperature sensors and alerting facilities.

Remote server monitoring is a valuable asset. All the servers here have embedded controllers with a web interface, so you can keep an eye on the status of critical components. The Lenovo and Broadberry servers offer more basic sets of features, whereas Dell and HP set the standard for remote monitoring – albeit at an additional cost.

Rack 'em and stack 'em

Most businesses start out with tower servers, but as they grow it makes sense to consolidate all IT services in a single location. Locating all hardware and associated network equipment in the same place makes it easier to manage.

Workloads will vary across businesses, so we've chosen four different systems offering a wide range of storage capacities, processing power and expandability. They're also all very good value, so turn the page to see which rack server fits your budget.





Broadberry CyberServe XE3-R130

Well-priced for small businesses, the XE3-R130 offers good features, plenty of power and room to grow

SCORE ★★★★★

PRICE £1,295 ex VAT from
broadberry.co.uk

Aimed at businesses that want their first rack server to pack plenty of punch without costing a fortune, Broadberry's CyberServe XE3-R130 offers a fine mix of features and value. Its single-socket Xeon E3 motherboard keeps the price down, while providing enough power to run a wide range of business apps – and it teams this up with hot-swap storage, plenty of RAID options and some interesting expansion choices.

At its foundation is Intel's 1U Server System R1304, kitted out with an S1200V3RPO motherboard. Intel offers a large range of boards for this chassis, but this model is a great choice, particularly as you can upgrade to high-performance SAS storage later on: simply snap a four-port SAS module into the dedicated slot at the front of the board. Intel offers two versions, with a sub-£100 module supporting 6Gbits/sec SAS plus stripes and mirrors, while the RMS25CB040 costs around £275 but adds RAID5 and 6, 1GB of cache and an optional battery pack.

Most businesses won't be in a rush

to upgrade, though: storage options on the review system are a fine starting point. Intel's C224 chipset provides a quartet of embedded 6Gbits/sec SATA ports, plus software-managed stripes, mirrors and RAID5. We could activate hardware-managed stripes and mirrors from the server's BIOS, but enabling RAID5 requires a £54 activation key.

If the server's dual embedded Gigabit ports aren't enough, the extra I/O expansion slot at the back will put a smile on your face. Module choices are extensive: take your pick from quad-Gigabit, dual copper or fibre 10GbE. Another bonus is that all these upgrade modules keep the single PCI Express slot free.

The CyberServe's high-end, 3.5GHz Intel Xeon E3-1275 v3 is capable of handling any workload a small business is likely to throw at it. Hyper-Threading support gives you eight logical cores to play with, while Turbo Boost 2 lets speeds step up to 3.9GHz to handle peaks in demand.

At 84W, this CPU has the highest TDP rating of the Xeon E3 v3 family, but it still delivered low readings in our power tests. With Windows Server 2012 R2 idling along, we measured a draw of 38W, which spiked at only 88W under maximum load.

ABOVE There's a huge amount of expansion potential thanks to the extra I/O expansion slot



"The high-end, 3.5GHz Intel Xeon E3-1275 v3 is capable of handling any workload a small business is likely to throw at it"

BELOW Broadberry helps to control costs by choosing a single-socket motherboard

The server includes 16GB of DDR3 UDIMM memory and the four DIMM slots support up to 32GB. Broadberry thoughtfully supplies a pair of 8GB DIMMs, allowing you to upgrade to the maximum capacity without having to replace them.

Noise levels from the three dual-rotor cooling fans are low enough to make the CyberServe suitable for a small office. However, we did find their faint whirring a tad annoying, so wouldn't want it on the desk next to us.

The CyberServe doesn't offer any general system-management tools, coming with only Intel's Active System Console (ASC) utility, which offers a status dashboard for the server it's running on. We could view values for critical components, and set ASC to send email

alerts for a range of hardware faults.

The Broadberry's embedded remote management beats Lenovo's ThinkServer. The included Intel RMM4 Lite plugin module shares access with the first Gigabit port and provides a much smarter web interface, which shows sensor data for critical components.

We linked sensor thresholds to email alerts and SNMP traps, and gained direct access to power controls. Usefully, the RMM4 provides KVM-over-IP remote control and virtual media services as standard.

The CyberServe hits the spot as an entry-level server. Its top-end Xeon E3 v3 has plenty of power for running business apps, delivers hot-swap storage and has room to expand. Add Broadberry's valuable three-year on-site warranty and you have a great-value buy.

SPECIFICATIONS

1U Intel rack chassis • 3.5GHz Intel Xeon E3-1275 v3 • 16GB DDR3 UDIMM (max 32GB) • Intel C224 chipset • 4 x SATA III • 2 x SATA II • supports RAID0, 1, 10 (5 requires key) • 2 x 2TB Toshiba Enterprise SATA hot-swap hard disks (max 4) • PCI-E 3 x8 slot • 2 x Gigabit Ethernet • I/O Module slot • RMM4 Lite • fixed 350W PSU • 3yr on-site NBD warranty





Dell PowerEdge R220

Ideal if you're short on space and cash – you won't find a smaller or better-value Xeon E3 server

SCORE ★★★★★

PRICE £475 exc VAT from dell.co.uk

Very small businesses looking for their first server will love Dell's dinky PowerEdge R220. This ultra-compact server measures only 41cm deep, so will fit on a desktop, in a wall-mount cabinet or even under a counter. With prices starting at £349 for the 3.4GHz Core i3 model, it's a bit of a steal. The review system came with a quad-core 3.1GHz Intel Xeon E3-1220 v3 and a double dose of memory, and Dell still managed to keep the price below £500.

Server-management options are extensive, but be careful, as they can substantially push up the price. The R220 comes with basic management enabled, giving remote access to the server's power controls and diagnostics using Dell's IPMISH command-line utility. The iDRAC7 web interface is ready and waiting, but you'll need to cough up £97 for an Express licence to enable it for remote monitoring. The iDRAC7 Enterprise card adds a dedicated network port and features such as remote control and power monitoring – but even the basic version costs £274.

We were pleased to see Dell's Lifecycle controller was a standard

feature, as this made local OS installation a breeze. Hitting F10 during boot presented us with a smart interface, where we chose Windows Server 2012 R2 as our OS, popped in the installation disc, and left it to load the OS along with the correct drivers.

You can use the OpenManage Server Administrator web console to keep an eye on the server's vital signs. We also loaded Dell's freely available OpenManage Essentials, which allowed us to monitor all the lab's SNMP- and WMI-enabled servers, workstations and switches (as well as the R220).

The PowerEdge is nicely built, with most of the front panel acting as a grille to improve airflow. Internal cooling is handled by four small fans, and the server is extremely quiet making it a good choice for offices that value their tranquillity.

Inevitably, what you gain in office space you lose in storage options: the R220 only has room inside for two cold-swap LFF or SFF hard disks. These are

ABOVE Whisper it, but a clever grille design helps cut down on noisy fans



"The PowerEdge is nicely built, with most of the front panel acting as a grille to improve airflow, and it's extremely quiet"

BELOW The inevitable side effect of a compact design: limited space inside



located on each side of the chassis, and their removable carriers can be easily unclipped and slid out.

RAID options start with Dell's embedded PERC S110 software controller. This is a standard feature on the R220 and supports mirrors, stripes and, although somewhat academic, RAID5. You can upgrade to Dell's PERC H310 PCI Express card, but we can't see the point in splashing out an extra £140 just to get 6Gbits/sec SATA support.

Along with the dual Gigabit and USB 3 ports at the rear, there's also an eSATA port. This can be used to expand capacity using external storage; if it isn't needed, you can disable it (along with the external

USB ports) from the server's BIOS. The server has a fixed 250W power supply and is very easy on the utility supply. With the OS in idle, the R220 only reached 30W; under extreme load from SiSoft Sandra, it peaked at 80W.

As you'd expect, internal expansion options are rather limited. The single PCI Express x16 slot and riser included has room to squeeze in only a half-length, full-height card. Perhaps surprisingly, though, the R220 can be used as a lightweight virtualisation testbed: it has an internal USB 2 port for booting a hypervisor.

The PowerEdge R220 packs a lot into its minuscule dimensions, and is small (and quiet) enough to fit just about anywhere. So long as the limited storage capacity won't cause you issues, it's a great choice as a first server.

SPECIFICATIONS

1U rack chassis • 3.1GHz Intel Xeon E3-1220 v3 • 8GB DDR3 UDIMM (max 32GB) • 500GB WD Enterprise cold-swap SATA hard disk (max 2) • Dell PERC S110 RAID controller • supports RAID0, 1, 5 • PCI-E x16 • 2 x Gigabit Ethernet • eSATA • 250W fixed PSU • Dell Basic Management • 1yr on-site NBD warranty

HP ProLiant DL80 Gen9

A high storage capacity, low price and powerful CPU make the DL80 our rack server of choice

SCORE ★★★★★

PRICE £989 exc VAT from hp.com/uk

SERVERS with big storage plans should pay attention, as HP has a present for you. Along with a high capacity, its new ProLiant DL80 Gen9 rack server is jam-packed with features and, best of all, delivers Intel's core-heavy Xeon E5-2600 v3 at a tempting price.

As with all its Gen9 servers, HP takes a different approach to system design. Although not as versatile as the flagship DL380 Gen9, the DL80 is highly scalable, allowing businesses to pay for only what they need now, with a view to upgrading in future.

The system on review – identified as 778640-B21 – is the entry model of the family, sneaking in at less than a grand. This includes a 1.6GHz Intel Xeon E5-2603 v3 CPU with six cores, and in that spirit of upgradability, a second socket is ready and waiting. HP also offers nine other models if you need more speed and cores.

The high-speed CPU is kept company by high-speed DDR4 memory, although HP has cut costs by providing only eight DIMM slots. Our review system came with a single 4GB stick but, with dual CPUs installed, it supports up to 256GB – easily enough for storage-centric apps.

Storage choices are also enticing: this 2U chassis can handle up to 12 hard disks. Our entry-level system has four



cold-swap drive bays, upgradeable to eight with HP's Enablement Kit.

RAID starts with the embedded Dynamic Smart Array B140i controller, which provides dual four-port SATA connectors on the motherboard. We could create stripes, mirrors and RAID5 arrays, and manage it easily using HP's Smart Storage Administrator utility.

HP offers configure-to-order (CTO) models if you want eight or 12 hot-swap drive bays and SmartDrive carriers, and there's also a big choice of SATA and 12Gbits/sec SAS Smart Array controllers. However, you can't upgrade from eight to 12 bays: you must order the higher-capacity model at the outset.

All versions have dual Gigabit ports, and HP offers an excellent range of network upgrades, including 10GbE, Fibre Channel and more. Even with a single CPU in residence, we had five PCI Express slots available. With two CPUs installed, we could add riser cards to increase the slot count to seven, and there's room over the PSU bay for a GPU card. The standard

ABOVE This is a cleverly designed server that can grow with your needs



"HP's iLO4 controller provides a wealth of information about server operations, as well as access to remote support"

500W cold-swap PSU won't be enough for a GPU, but you can upgrade to 800W redundant PSUs.

The E5-2603 v3 and its low 85W TDP makes the DL80 a real power miser. In idle, we clocked the review system drawing 45W and peaking under load at only 71W – amazingly, that's 9W less than Dell's Xeon E3 v3-equipped R220.

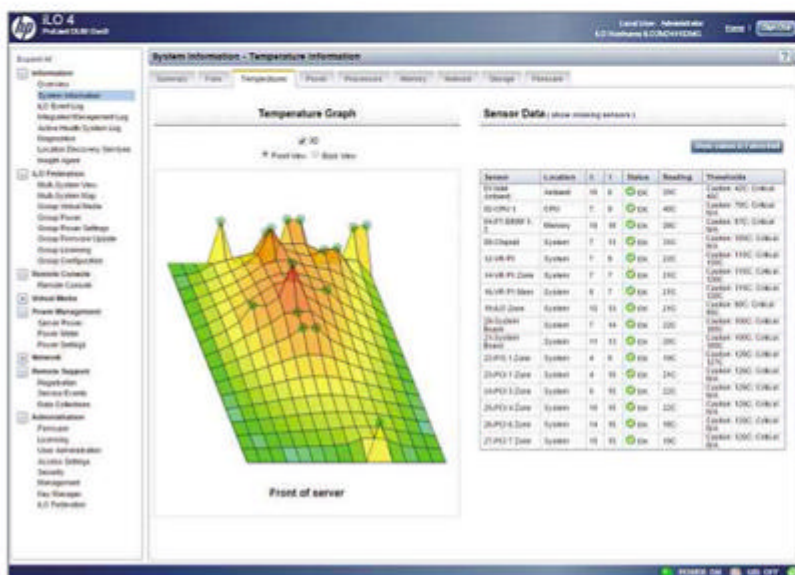
Server management doesn't get any better, either: HP's iLO4 controller provides a wealth of information about server operations, as well as access to remote support. We could control the server's power remotely, but you'll need an Advanced licence to control the OS.

OS installation took less than an hour using the embedded Active Intelligent Provisioning tool, with the System Management Homepage browser interface on hand to provide basic local monitoring HP's Insight Control handles general system management, and we used HP's iOS Insight Online app with our Passport account to view registered systems, monitor support cases and check support contracts.

You'll need to choose carefully, as there are so many options and models, but HP's DL80 Gen9 is an ideal choice for a rack server that can grow with you. Its scalable design makes it a solid long-term investment, while the power of the Xeon E5-2600 v3 and low price earn it a place on our A-List.

SPECIFICATIONS

2U rack chassis • 1.6GHz Intel Xeon E5-2603 v3 (max 2) • 4GB 1,600MHz DDR4 RAM (max 256GB) • HP Dynamic Smart Array B140i • supports RAID0, 1, 5, 10 (max 12 LFF) • cold-swap four-bay backplane • 2 x Gigabit Ethernet • 7 x PCI-E 3 (with 2 CPUs) • 2 x cold-swap fans (max 6) • 500W cold-swap PSU • HP iLO4 Standard • 1yr on-site NBD warranty



LEFT HP's iLO4 controller offers the best embedded remote-management tools around



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Lenovo ThinkServer RD440

Management is basic, but this is a powerful server with great storage potential at a competitive price

SCORE ★★★★★

PRICE £2,309 exc VAT from serversplus.com

Lenovo kicked off this year by officially completing its acquisition of IBM's entire System x portfolio: in one swoop, it goes from bit-part player to centre stage in the global server market. However, it has no plans to change its well-established ThinkServer brand – squarely aimed at SMBs – and in this review we look at the RD440 general-purpose rack server.

This 2U system targets jobs such as file and print, collaboration or web serving, and will appeal to businesses that want a big storage capacity at a low price. The system on review has eight hot-swap LFF drives bays but Lenovo also offers models with 12 LFF or 16 SFF bays.

Lenovo provides RAID options to match, with the embedded ThinkServer RAID 300 controller supporting SAS and SATA drives plus stripes and mirrors. A £60 upgrade key activates RAID5. Want more? Lenovo offers three optional PCI Express RAID controllers with a choice of cache memory, BBU or supercapacitor protection and dual-drive redundant RAID6 arrays.

There's plenty of power on tap, with support for two Intel Xeon E5-2400 v2 CPUs and a maximum 192GB of memory. Our review specification shows Lenovo has



a sharp eye on value: the price includes dual quad-core 2.4GHz Xeon E5-2407 v2 CPUs and a healthy 48GB of DDR3 RAM.

We like Lenovo's build quality, too: the chassis and drive carriers are solidly constructed. The eight-bay model has room for a DVD drive up front, partnered by an Intelligent Diagnostics Module that provides visual warnings of problems with critical components (such as power, fans, memory and CPUs). Should you need to make any replacements or upgrades, a well-designed interior makes it easy to access all the important areas – and with six free PCI Express slots, the RD440 has plenty of room to grow.

You'll find five hotplug cooling fans in front of the motherboard. This means the RD440 can't match HP's or Dell's 2U rack servers for low noise levels, but it's still quiet compared to previous-generation rack servers. It certainly won't be an issue in a server room or cabinet.

The Xeon E5-2407 v2 CPUs only offer four threads apiece, but their 80W TDP made its mark in our power tests. We measured a low draw of 94W with Windows Server 2012 R2 in idle. Even under heavy load from SiSoft Sandra, the test peaked at only 151W.

Our review system included only one 800W hotplug PSU, but

ABOVE Rugged design means you can trust the ThinkServer to last for years

we recommend you add a second for redundancy. Lenovo provides three Gigabit ports, one of which can be shared or dedicated to Lenovo's embedded ThinkServer Management Module (TMM). This wants for features compared to HP's iLO4 or Dell's iDRAC: its web interface provides basic monitoring of critical components and access to power controls, but KVM-over-IP remote control and virtual media services require a £52 upgrade.

For OS deployment, we booted the server with Lenovo's EasyStartup

"Should you need to make any upgrades, a well-designed interior makes it easy to access all the important areas"

disc. With the aid of its install wizard, it didn't take long to load Windows Server 2012 R2. We prefer Dell's Lifecycle Controller and HP's Intelligent Provisioning, though, which do away with

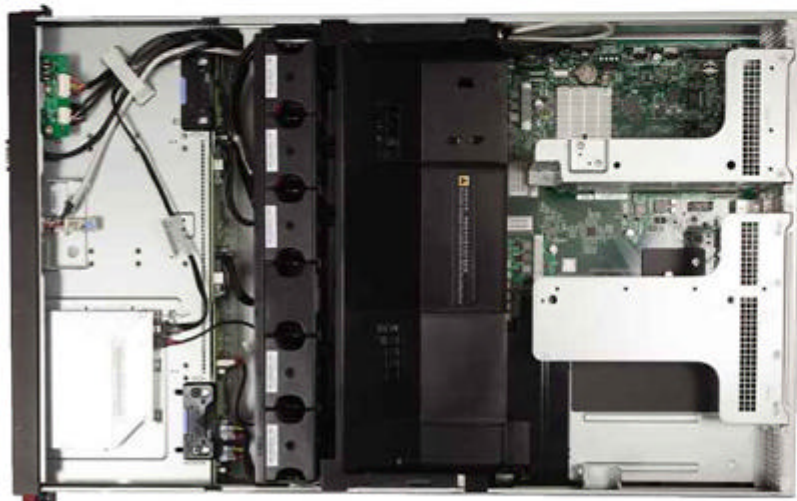
the need for a boot disc.

We've no complaints about the free ThinkServer EasyManage software, which offers a generous basket of general system-management tools. It monitors SNMP- and WMI-enabled systems, runs network discoveries to find them all, and – for the RD440 – provides a good insight into installed hardware, system performance and detected faults.

The Lenovo ThinkServer RD440 is marginally cheaper than Dell's equivalent, the PowerEdge R520, so if your eye is firmly set on the price – and you want dual Xeon E5 power and great storage potential – then it's a fine choice. All the same, Dell wins for remote server management and easy OS deployment. ●

SPECIFICATIONS

2U rack chassis ● 2 x 2.4GHz Intel Xeon E5-2407 v2 ● 48GB DDR3 RAM (max 192GB) ● 2 x 300GB Seagate 15K SAS hot-swap hard disks (max 8) ● ThinkServer RAID 300 controller supports RAID0, 1, 10 (5 optional) ● 5 x PCI-E 3 ● PCI-E 2 (with 2 CPUs) ● 3 x Gigabit Ethernet ● 800W hotplug PSU (max 2) ● TMM Basic ● Lenovo EasyStartup and EasyManage software ● 3yr on-site NBD warranty

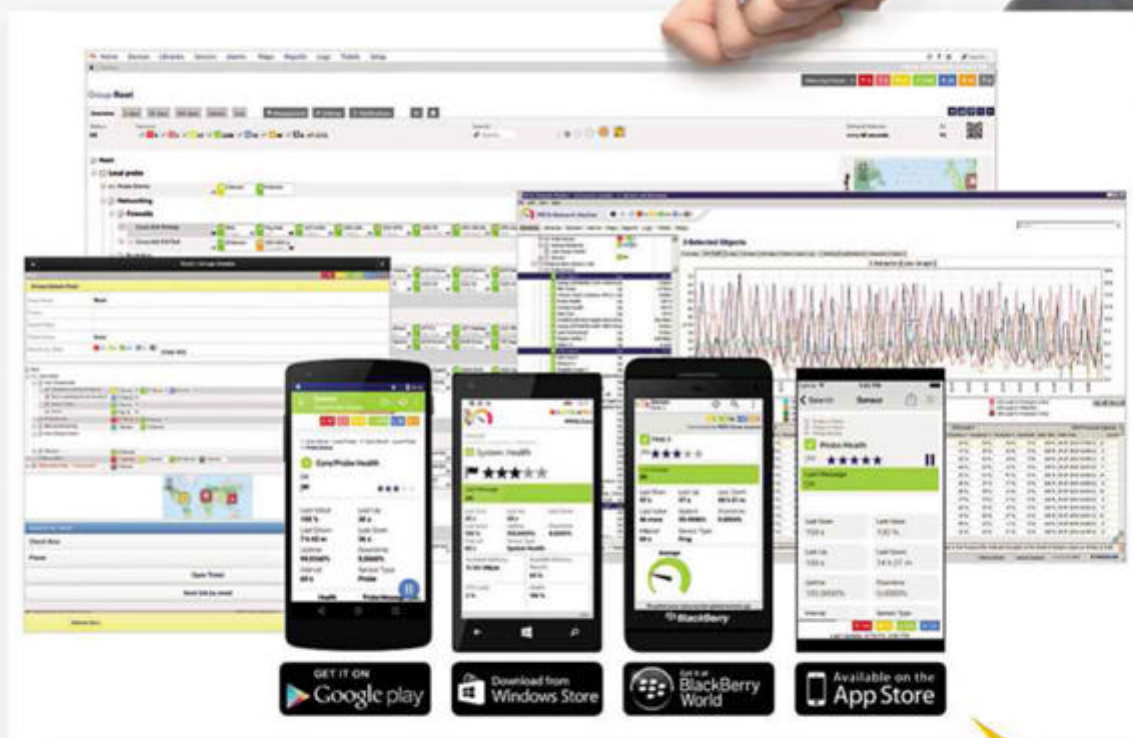


LEFT Lenovo packs in the power, with support for two Intel Xeon E5-2400 v2 CPUs and a huge 192GB of memory

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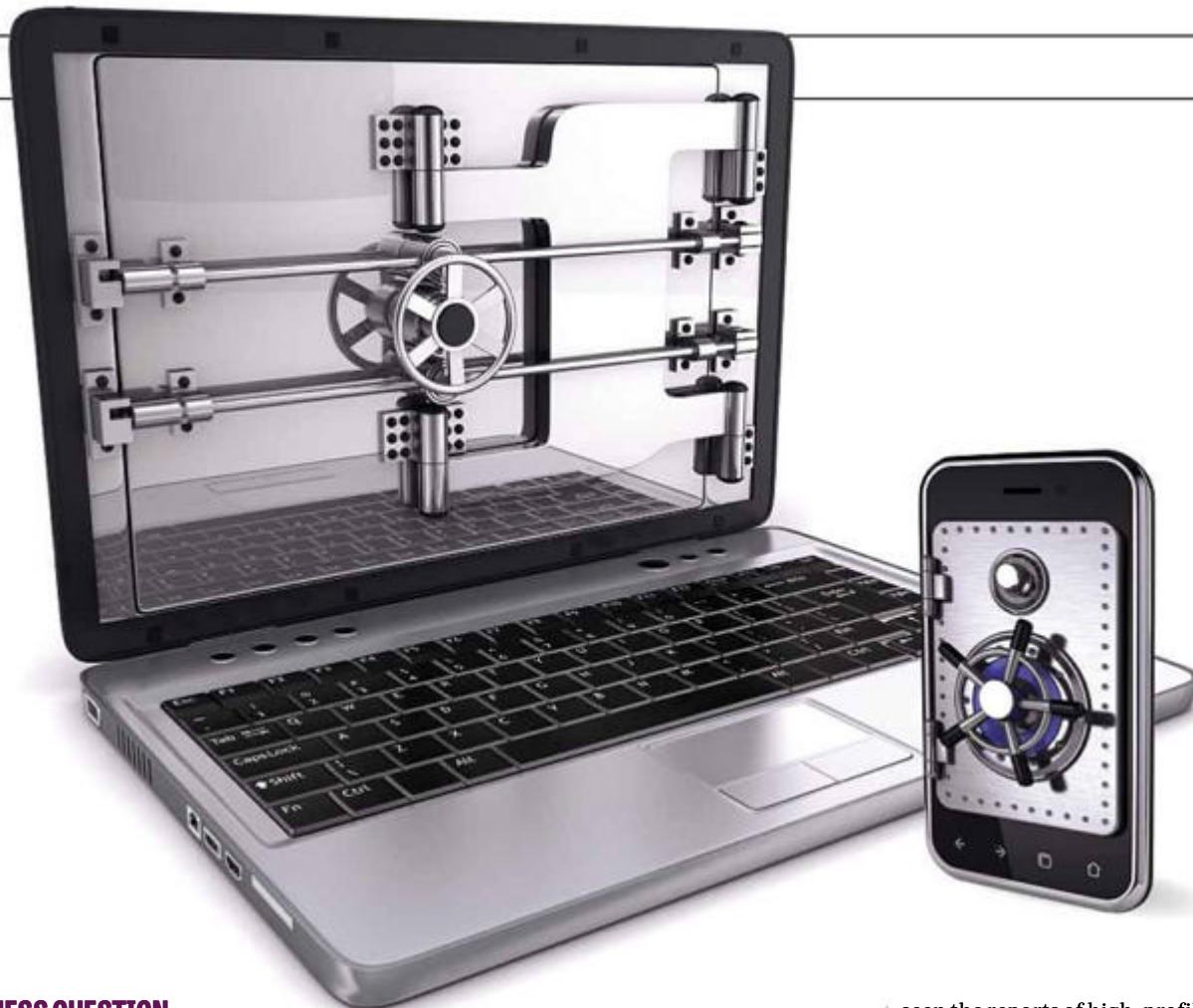
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THE BUSINESS QUESTION

How should your firm use encryption?

Data is valuable – and can be legally sensitive too.

Darien Graham-Smith asks the experts what steps businesses should take to keep it safe

Encryption may not sound like an inviting topic. Investing in an encryption framework doesn't do anything for your bottom line, and the implementation is associated with slow, intrusive processes that make users and IT managers shudder alike. But using encryption could save your business from a lot of trouble.

■ Who needs encryption?

You might imagine that only organisations working on confidential projects need to worry about encrypting their data. Yet while your employees may not be carrying around top-secret blueprints, their systems may still hold data that needs protecting.

"Even if you're a small business, you're still subject to the Data

Protection Act," noted Sian John, security expert at Symantec. "The law requires that you protect personal data from being stolen, misused or shared. If you have customer details stored on your computer, then using encryption allows you to say: 'I've taken precautions to ensure that personal data doesn't get lost.'"

"There are also European regulations," she warned. "We have new, general data-protection regulations coming down the line, which will require that you notify of any breach to your system."

Legal considerations aside, protecting customer data is simply good business sense. "We all have an expectation of privacy," noted Anthony Merry, director of data protection at Sophos. "We've all

seen the reports of high-profile data breaches in the newspapers. Customers know that if you have a data breach, they might have their identity stolen as a result. You can increase customer satisfaction by ensuring you protect their data."

Aside from accidental loss, encryption can also be a valuable defence against hacker attacks. "We've noticed an increasing amount of malware that attempts to steal data," warned Merry. "A data breach isn't just data leaving the organisation – it's data leaving in a form that's usable to an attacker. If a hacker gets at your files, but only in encrypted form, they can't do any harm."

■ What needs protecting?

Without a doubt, the most important data security measure you can take is to apply full-disk encryption on all mobile devices. "Let's say somebody

steals your encrypted laptop," Merry explained:

"If they don't have the username and password, they simply can't access the data on it. They can't boot it. They can't even access the files if they take

out the disk and try to mount it from another system."

File-level encryption has a role to play too. "We attach files to emails, copy data to USB sticks and pass them around – there are lots of ways to share data, and as end users we do it instinctively," Merry said. "For example, let's say I copy an Excel

"While your employees may not be carrying around top-secret blueprints, their systems may still hold data that needs protecting"



spreadsheet from work onto my USB stick so I can work on it at home. A USB stick is easy to lose – you pull your keys out of your pocket and the USB stick falls out. As far as the law is concerned, if someone can pick up that USB stick and potentially make use of the data contained on it, that's a data breach. It's the same type of situation if you're storing potentially secret or proprietary information on Dropbox, because you don't know who might access it."

It's worth thinking about tablets and smartphones too. "With company devices, you may choose to manage all aspects of security, including the apps users install," noted Merry. "Or, you can have a BYOD scenario. In that case you can say: 'It might be your device, but if you're going to have company data on it then you need to protect it.' Devices such as mobile phones have built-in encryption that you can activate."

Desktops and servers are rather less likely to fall out of pockets, but if you're unlucky enough to be the victim of a burglary, you could be looking at a data-loss disaster. "You do get thefts from businesses – even large companies with big data centres," warned Sian John. "And encryption is so easy to turn on now that it's worth doing."

Encryption can also provide a secondary benefit when it's time to retire old hardware. "When you go to recycle your computers at the end of their life, make sure you've destroyed data on them," added John. "If you're using encryption, it's easy to wipe that drive so that it isn't recoverable."

■ Performance and management

Doesn't encrypting and decrypting data tax the processor, meaning your systems will consume more power and perform more slowly? "There's



been a focus on making encryption quicker, so it doesn't have any impact on your systems," said John. "From the user perspective, there's a registration process when you first unlock the system, but it's seamless thereafter – you don't even know it's there."

"Modern Intel processors have a set of instructions called AES-NI," added Merry. "Basically, these perform hardware acceleration of the encryption inside the CPU." Similarly, some storage devices include their own encryption processor, which takes care of encryption and decryption at the controller level. As a result, the operating system doesn't have to do the work itself, or even know that your data is encrypted.

"Businesses that want to roll out encryption shouldn't need to buy new servers or hardware," concluded Merry. "Encryption shouldn't have a perceptible impact on productivity or system performance. It means we can keep our users productive while keeping data secure."

However, Sian John did sound one note of caution: "Possibly the most difficult thing, in terms of usability, is to use encrypted email," she noted.

ABOVE Modern encryption systems focus on manageability as well as performance

"If someone can pick up a USB stick and potentially make use of the data contained on it, that's a data breach"

"Some companies use encryption at the back-end, so emails are encrypted after they leave your outbox; they're decrypted at the gateway of the person you're sending it to, before it gets to their desktop. But sometimes you need person-to-person encryption – for example, if you're a legal firm handling sensitive documents. For that, you do need to find a way of sharing keys directly between you."

■ Avoiding the pitfalls

Encryption isn't a technology you can simply release into your organisation: you need to apply it in a systematic way to make sure data doesn't slip through the gaps. "Businesses should have a data-protection strategy in place," advised Merry. "Look at what employees do, how they use

data and how data flows naturally inside and outside of an organisation. Then come up with a plan, and communicate it: individual employees should be aware of the business' data-protection

strategy and what it means to them."

And it's important to plan ahead. As Sian John warned: "If you're rolling out encryption in a corporate environment, think about additional decryption keys. A lot of effort has been put into making it easy to recover if a user forgets their password, or leaves the organisation. You can have a master key to decrypt their PC once they've left. You don't want to set up a system where employees are encrypting stuff that you're not able to get back again." ●



The expert view Davey Winder

It's all well and good applying a mixture of full-disk and file-level encryption on your devices, where you have control over the encryption process and the keys to unlock it. But what about encryption in the cloud, where an increasing number of SMBs are depositing their data these days?

The average small business may well assume its cloud service provider is taking care of everything, but there are important questions to ask regarding the point at which the encryption is applied. It's a given these days that data will be encrypted while in transit – a secure connection using Transport Layer Security (TLS) or Secure

Sockets Layer (SSL) is a security default after all. But is that enough for you to feel safe about your data in the cloud? Not in my book: sending your data to a cloud service where it may be stored in unencrypted form, or where the keys are held by the service provider, undoes your good work.

Indeed, there are occasions when a cloud service provider might need to access unencrypted data, from applying deduplication to reducing storage requirements, through to enabling law-enforcement access when legally required to.

In such circumstances, the answer is to audit your data and determine what is simply too sensitive to allow any hint of third-party access – and either encrypt it before it leaves your network

boundaries, or not store it in the cloud at all. There is another option, which involves using a third party to manage your encryption keys: as long as they can't get to your data, and the service provider can't get to your keys, you get guaranteed key management, backups and availability.

However you run it, it's vital that you understand how your data is encrypted in the cloud: question your service provider about key management, and ensure your security posture is as robust as you want it to be. Remember, data encryption isn't a one-stop solution for effective network and data-security strategies. It won't stop a breach. What it can do is mitigate the impact of a breach that occurs, and that has to be good for business.

Document management

Retaining records doesn't have to mean hanging on to reams of paperwork. **Steve Cassidy** explains the value of going digital



■ Document management? What exactly does that mean?

Conventionally, it means digitising paper documents, for the purpose of archiving and search. The simplest document-management systems are often laptop-based filing systems, which let you tag, categorise and collect together disparate document types. At the other end of the scale you can get huge, company-wide knowledge-base-type systems.

■ Scanning in paper documents sounds rather old hat!

Perhaps, but it's still very relevant. Even though many businesses now function by way of databases and websites, there'll always be a need to retain records of your business transactions. One approach might be to print out all your internal materials, so they can be physically filed alongside incoming paper documents – but it's more efficient to digitise the incoming paper, and maintain the completeness of the record that way.

■ So it's basically a digital filing cabinet?

Today's systems are smarter than that: they can collect all your business inputs and outputs in a fully searchable database that's flexible enough to make sense of a request that may later come in from left-field. For example, suppose that you're a van-hire company and one of your vans is captured on CCTV at the time a crime is committed: it's easy to pull up the renter's licence details, as well as any records of payments, signatures on contracts, and so forth.

■ Will all this digitising require a huge amount of storage?

Not as much as you might think: a 32GB USB stick can store more than a million PDF documents. In some cases, document management can even reduce your digital storage needs, by deduplicating multiple copies of the same document. I remember one business that had its logo embedded as a graphic into Word's standard template, meaning that no employee ever produced a document smaller than 1MB. Deduplication of everybody's archived documents slashed the company's total storage footprint.

In practice, you'll probably end up investing in some new storage, but it doesn't have to be horrendously expensive. You can use fast storage up-front for processing new material, but slower media on which to keep older, potentially deletable archives. This sort of tiering is becoming accessible even to smaller organisations, as key technologies such as iSCSI trickle down.

■ Still, it sounds like a long slog to implement.

Scanning and cataloguing a million documents doesn't happen in a week, and such projects do tend to have a slow, tentative start. But a modern scanner can digitise 50 pages per minute, and once everyone starts to see how the system will benefit them, there tends to be a groundswell of enthusiasm and a rush to complete the project.

And at the end, as well as a comprehensive digital record of your transactions, you may find you've gained a significant amount of extra office space, once all your originals have been sent off to archival storage. Think about the amount of paper, say, a typical legal firm keeps around, and you'll see how digitisation can free up enough space for another partner.

■ All right: what software should I be looking at then?

It may not be you who should be looking, at least on the first pass. A document-management

system has to suit your daily customs and practices, so there's an argument that the initial beauty-parade judges should come from your user community, rather than management or technical staff. If the system is a good fit for your business, that in turn drives the IT case. Don't exclude your

technical whizzes entirely, though: the skillset can be useful in identifying if you're being asked to pay for a shiny veneer over the top of a pretty standard offering.

■ It sounds like we're entering a very long-term relationship. What happens if we lose support?

Ongoing support is an overarching IT issue, and document management isn't an exception. Before investing in your chosen platform, make sure that the product is sufficiently open to allow you to migrate away if need be. Sign up to the user group for the product – and review your relationship with the supplier, and the market competition, at least once a year. You may have to keep your documents for seven years, but there's no reason to be locked into one system for all that time. ●

“At the end, as well as a comprehensive digital record of transactions, you may find you've gained extra office space”

The jargon

Fixed forms Bits of paper that let humans feed data directly into the document-management system via OMR (see below). Less structured forms may rely on complex and less reliable handwriting recognition.

Optical mark recognition (OMR) Simply put, the ability to read and interpret content on paper. This can be used, for example, to convert ticks on paper forms into searchable digital metadata.

Portable Document Format (PDF) The daddy of static, searchable, generally read-only file formats. Now deeply embedded as an archival standard, although Adobe occasionally moves the goalposts with new versions of the format.

Version control In this context, the process of relating documents that may be scanned at different times but which are connected by a single business reference.

Ensure Secure Sharing & Protect your Revenue Streams

Locklizard's document security software prevents unauthorized document sharing and piracy. It controls access to and use of your information both inside and outside your organization, so you can securely, and cost effectively, distribute and manage your digital content.



1 Stop Unauthorized Access

Documents are locked to specific users and their devices and will not work if users distribute them to others. You can also enforce the location from where they can be used (e.g. office only).



2 Control Document Usage

Decide whether authorized users can print your documents and if so how many times. Stop screen grabbing, and change access controls even after distribution.



3 Expire & Revoke Documents

Set documents to automatically expire after a given no. of views, prints, days, or on a fixed date. Instantly revoke access to documents at any stage no matter where they reside.



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See when users open and print your documents. Apply dynamic watermarks displaying user information to viewed and/or printed information to discourage sharing of printed copies.

Locklizard document security software is used worldwide by information publishers either selling content or ensuring compliance, corporates protecting trade secrets, or providing a controlled method to share their information, and government agencies concerned over potential misuse of their information.

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“The return on investment to our company has been immediately evident. We are now creating new products for our electronic portfolio without fear of seeing them being distributed through unauthorized channels.”



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For 25 years TSD policy was to send out paper based manuals for its product lines to new customers. Manuals could take 7-10 business days from ordering to reach the customer, and could be copied and distributed outside of their control. They needed a solution so customers received instant gratification upon purchase and achieve a 'greener' result.

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JON HONEYBALL

“Microsoft is back where it should be, with a solid product that’s carefully considered, polished and well delivered”

Windows 10 has the goods to place Microsoft back into the hearts of users, with the licensing changes of most significance

Here are some words I wasn’t expecting to type any time soon: I’m genuinely excited by the Windows 10 announcements. There, I’ve said it. I’d been excited by Windows before – excited enough by Windows 3 to jack in my full-time job and launch my own firm specialising in supporting it. Windows NT was a joyous thing too, and NT4 was a positive delight. In the business arena, Windows XP was strong and became well understood, controlled and deployed. I didn’t particularly like Windows 7, but its 64-bit version was certainly a solid update to XP. I didn’t enthuse about it simply because it didn’t move anything forward in a meaningful way.

The rest have been disappointing, verging on garbage (let’s not talk about versions 8 and 8.1, whose limitations and blinkered thinking still make my mind spin). Vista? Oh, perleaze. Windows 2000, especially in its server version, receives a nod for introducing Active Directory, although that didn’t really work well until 2003. The various mutations of Windows 95 (ME being the worst) were adequate in a toy-like way, but paled in comparison to the NT work being done at the same time.

Now Windows 10 finally brings Microsoft back to the place where it should be, with a solid product that’s carefully considered, polished and well delivered. That it’s taken the company the proverbial “three versions until it’s right” since the launch of Windows 8 shouldn’t come as a great surprise to long-time

Windows watchers – finally the grown-ups have taken back control of the building.

I don’t say that lightly, as I’m sure the work being pushed forward by Steven Sinofsky was well intentioned, and he did have a strong history of delivering good stuff. Perhaps history will show just how much pressure he was under to deliver something, anything, as a response to the terrifying threats from Android and iOS. Perhaps the lumpen behemoth that is the Microsoft Windows team simply couldn’t respond any quicker, and Windows 8 was a horrible compromise that delivered just enough to get something out the door, while recognising that it fell far short of what was needed. Who knows? The PR bunnies were spinning furiously at the time with claims that Windows 8 was utterly fantastic, but then they would say that, wouldn’t they?

There’s much to like here in Windows 10. There’s now proper consideration of how touch can be made to work well in both the tablet

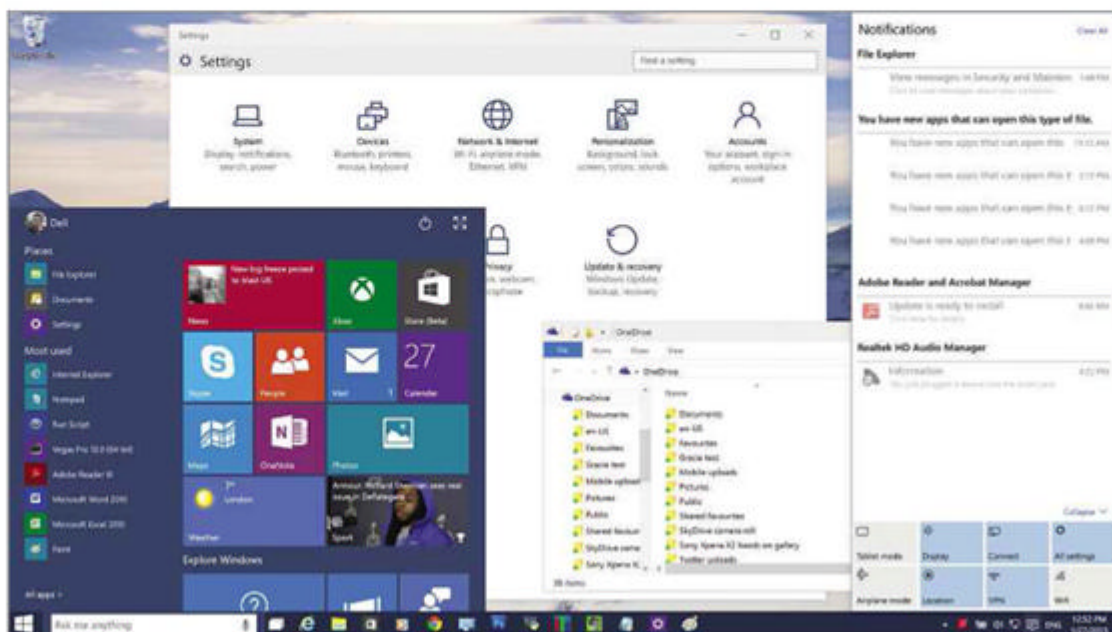


Jon is the MD of an IT consultancy that specialises in testing and deploying hardware
@jonhoneyball

BELOW The Start menu can be adapted to fit screen sizes from tablets up to multi-screen desktops

and desktop spaces, and joined-up thinking about how a tablet can convert to and from the laptop function as you add or remove a keyboard. There’s proper thinking too about how Modern apps can be run both full-screen and also within a window on a desktop. Consideration has been given to how to bring the Start menu up to date in a manner that encompasses all modes of use, from the smallest tablet through to a large multi-screen desktop. But it’s the licensing changes that have piqued my interest most: Microsoft has announced that, for a period of one year following the release of Windows 10, customers running 7 or 8.x can upgrade for free. This includes business customers that are running the Pro version, but excludes Enterprise version customers who will be running on a full enterprise licence, and who would therefore receive the upgrade as part of their rolling plan anyway.

This is a significant and welcome move by Microsoft. You might recall that I asked Microsoft to extend such an offer to Windows XP customers





Jon Honeyball
Opinion on Windows, Apple and everything in between – **p110**



Paul Ockenden
Unique insight into mobile and wireless tech – **p113**



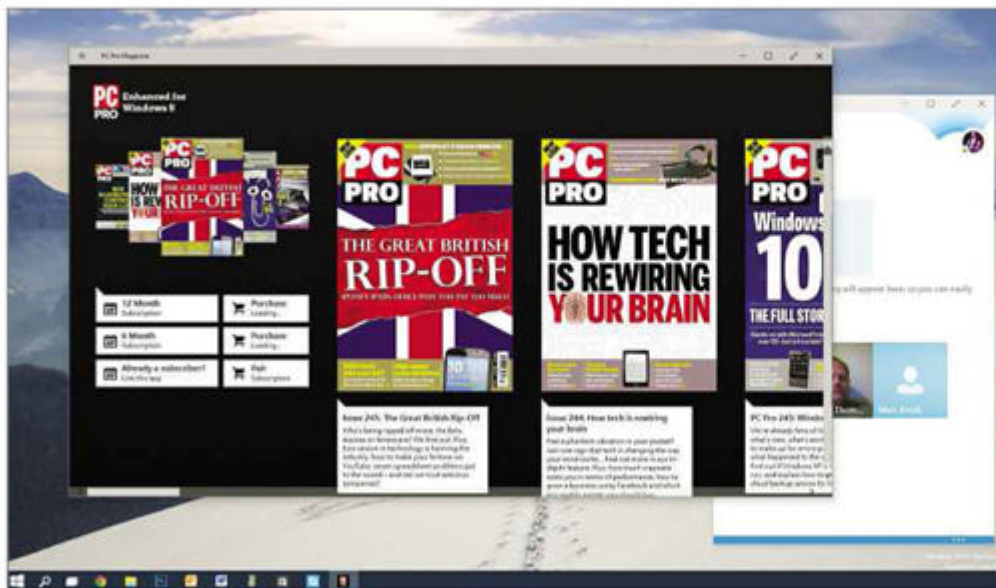
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Can bandwidth monitors be trusted? – **p116**



Davey Winder
Keeping small businesses safe since 1997 – **p118**



Steve Cassidy
The wider vision on cloud and infrastructure – **p120**



when the software finally went end-of-life last year. It turns out that there isn't actually a direct upgrade path from XP to 7 or 8 without going through Vista, so I think you'd have to agree that Microsoft painted itself into a corner with that one. Writing some sort of utility to patch things up so that a direct upgrade could work was almost certainly viewed in Redmond as being far too much of a ball-ache to be worth the effort.

This free upgrade from 7 and 8 is to be strongly welcomed, and what's also interesting is that you'll be supported for ten years – not only for bug fixes and patches, but also for new features. Microsoft has been rather less than clear about what this will actually mean in practice, however: will there be a Windows 11 coming along in a few years' time? Seems not; Windows 10 becomes "Windows" and that's it, with small, fast incremental upgrades and new features from now on, which will be free if you upgrade within this time frame.

This is all hugely important to Microsoft because it's battling with a horrible problem of fragmentation. It really needs to get all its customers up onto a common platform, including business users, so this is a one-off attempt to make it sufficiently attractive for anyone who's running versions 7 or 8 to move up to 10 for free.

What's equally interesting is the company's plan for the server side.

Here Microsoft has finally woken up to the blindingly obvious point that businesses are far more cautious about upgrading, especially on their core servers. By upgrading, I mean that almost weekly flood of patches, fixes and so forth that seem to spew from the software vendors.

To help manage this, Microsoft is introducing two new "branches" of the Windows codebase designed specifically for business users. The first, called "Long Term Servicing", is aimed at devices you want to keep patched for security and critical updates but that demand maximum stability otherwise – those mission-critical computers that must be patched but not fiddled with otherwise. This program will run for five years of mainstream support, and then a further five years in extended support. You'll be able to use Windows Server Update Services (WSUS) to control how these fixes are applied.

The other version is called "Current branch for Business" and is for customers who want not only the security patches and updates, but also the new feature updates – but only once they've assessed them for quality and compatibility and decided to press "Go". In other words, it will bring all of the consumer updates, but in a more time-controlled manner for the managed business platform.

So has Microsoft really woken up and smelt the coffee? With Windows 10 I think there's a strong possibility that the company can regain relevance and confidence in both the business and consumer markets, but there are still a few flies in the ointment overall.

ABOVE Modern apps now run in a much more sensible windowed mode

"Microsoft is battling with a problem of fragmentation – it needs to get all its customers up onto a common platform"

There's no ongoing strategy for Windows RT, the ARM-based version that Microsoft released on its Surface tablets. I'm really quite annoyed about this, because it's just another example of Microsoft's bad history of launching onto non-Intel x86 platforms and then walking away from them. It did it with NT, which was on four platforms originally: x86, PowerPC, MIPS R3000 and finally the DEC Alpha. Then it released the Intel Itanium version, which ran throughout the 2000s.

The recent release of the ARM processor version of Windows 8 was fascinating for one reason – it couldn't run Win32 code at all, and hence was immune from Win32 malicious code. You might think this was a good idea, and indeed it was. Microsoft even ported a version of Office over onto the RT platform, although like all non-Intel versions of Windows Office platform, it was stripped of significant functions.

There will be some sort of upgrade, but it won't be Windows 10. The conclusion is obvious – Microsoft's foray into the world of ARM for Windows is dead and buried. Maybe it achieved its intended goal of encouraging Intel to pull its finger out and deliver lower power-consumption chipsets. That's undoubtedly true, but I'm not at all sure that Intel was waiting for such a push, and wasn't already doing the necessary work.

And why am I so annoyed? Because the ARM version of Windows 8 actually came closest to what Microsoft was originally trying to do with this OS. It was focused almost entirely on the new touch interface and squarely aimed at the tablet marketplace (although desktop ARM devices could certainly have been interesting). The problem, as always, was that the actual implementation was incomplete: the port of Office to the desktop UI showed just how far behind the Office group was lagging, and the fact that Microsoft made an exception solely for the Office group, to allow it to run old-style apps, showed just how deep a hole the whole project had fallen into. Never mind, it has all come to naught; yet another non-Intel experiment from Microsoft that the company has refused to stand behind.

Office for iOS and Android

Now for the good news. The arrival of Office on iOS a few months ago was significant because it showed that Microsoft, in its post-Ballmer

incarnation, was prepared to actually think about what customers wanted, rather than just trying to corral them into buying what Microsoft wanted to sell them.

The iOS version is functionally limited of course, but it's useful for simple- to medium-weight work. Just don't try putting anything too complex near it, or you'll find that its capabilities simply don't stretch that far – some areas will render correctly, such as conditional formatting cells in Excel, but the user interface to change those settings is missing in action. Nevertheless, it's now free for personal use, with certain advanced features paywalled, and bundled as part of a personal or business Office 365 subscription.

The arrival of Office for Android is possibly even more significant, since the fact that it's now available for the two biggest tablet platforms, alongside Windows, may well represent a tipping point for those devices. I realise it might sound a bit sycophantic to prophesy about such a tipping point (and the accompanying move from content consumption to content creation) merely because Office has arrived – after all, there have been a number of pretty good office apps for those platforms for a while now – but the fact is that they haven't really grabbed the public imagination in the way that "real" Office from Microsoft will do. Suddenly, the somewhat-less-than-imaginative middle management of company IT departments is waking up to the arrival of Office for iOS and Android, and for some of them this appears to "legitimise" these platforms.

Great care still needs to be taken in using iOS and Android in a business environment, since the management tools will need to be extended to these platforms too, but it can be done. The range of hardware supported by Office for Android is somewhat limited, at least in the beta versions, and I'll need to check out how this has panned out in the final release that emerged in late January. But be in no doubt that Microsoft is now deadly serious about wanting its customers to use Office, even if it isn't on Windows itself, and this is a brave step that has to be applauded.

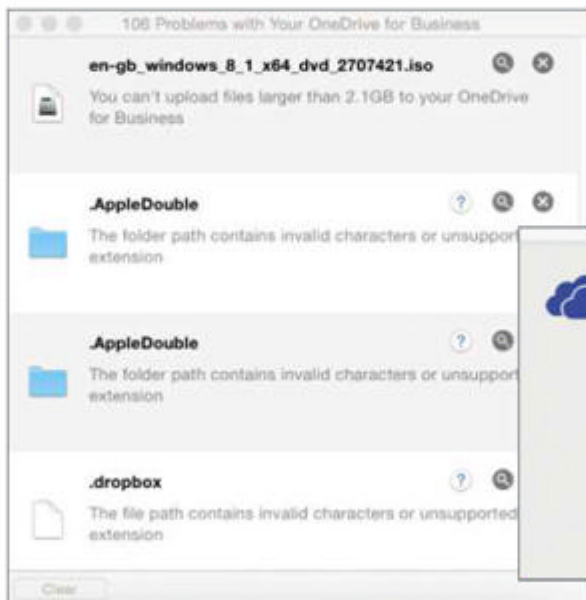


OneDrive woes

Now for the bad news. Despite all of the good things I've mentioned above, there are two big howlers. Let's start with OneDrive for Business for Mac, which was promised for the end of last year but then didn't materialise. Finally Microsoft has released a beta version of this tool, which I fired up, pointed at some local storage and told it to get on with the task of creating a cloud-based copy. This was what I wanted it to do, but the experience only lasted for a few seconds before the app collapsed in

ABOVE Although functionality is limited, Office for iOS and Android is useful

BELOW Unfortunately, OneDrive for Business for Mac is unusable, throwing up errors at every turn



storage platform for both OneDrive and OneDrive for Business. I can't help feeling that what the company has just released is some sort of sop to those of us who have been loudly complaining that we're paying for OneDrive Business storage as part of our Office 365 E3, and that we'd quite like either a working client or a downgrade option back to plain OneDrive. If Redmond believes that code of this rank quality, on top of an underlying platform with those restrictions, will suffice to make us happy, then I have some bad news: pull your fingers out and deliver something that business Mac users will want to use, because this really isn't good enough.

I now shift my attention to the just-released Outlook for iOS, over which I'm in a real quandary. After initial use, I'm stunned by it – it's quite amazing. The way it can

a pile of smoking debris. OneDrive has a very restricted set of file types and filenames that it will tolerate, and it throws up error after error if you dare to employ any that it doesn't like. Worse still, it told me that it couldn't cope with any file bigger than 2GB, and that some of my filenames were too long.

Frankly, I despair. Yes, underlying this platform are the old SharePoint storage services, and these are in dire need of bringing into the 20th century, let alone the 21st. It seems that Microsoft agrees, because it's announced that there

will soon be one unified

categorise emails into “important” and “not important” is superb; it’s fast, fluid and responsive. I entered into it a pile of Office 365 account logins, and even gave it my Dropbox login, and it just worked. It’s great, and I was hugely impressed. Except for one point: this is in fact as much a “Microsoft Outlook” product as my left leg...

Microsoft bought the company behind this product only a few months ago, and has simply rebadged its code – from there it’s downhill. First, this isn’t a phone-centred client app, but actually a combination of a phone-based app and a cloud service. The cloud service runs on Amazon Web Services (AWS) servers, which I have no problem with because AWS is a solid platform. However, I don’t recall there being any indication when I installed the “app” that this would happen. Worse still, when I give it my login information, it isn’t used by the client – oh no, this login information is sent to the AWS cloud servers and they log in on my behalf. It’s also the AWS cloud servers that do all the clever categorising of my emails, then send the email data back to the client running on my phone. Similarly, if I need a Dropbox file that’s no problem: it will log in to the cloud and get it for me. Which means I’ve just handed my login information over to a third-party tool running on a non-Microsoft server platform, which is logging in on my behalf.

That might not bother you, but for people who work in a regulated environment it will be a disaster. Worse still, you have no centralised management of this information. However, Microsoft has decided that it’s tickety-boo to slap a “Microsoft Outlook” label onto this technology and shove it out the door, without any attempt at re-engineering it for the Microsoft platform. I suspect there hasn’t even been a proper, long-trousered security validation, and the Office blog is somewhat short on factual clarity about what’s going on too.

Yes, I’m very annoyed: this cavalier rebranding and callous and deliberate obfuscation of what’s going on is exactly the sort of behaviour that makes people distrust Microsoft. I hope heads roll over it.

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PAUL OCKENDEN

“I’m going to suggest an alternative to migrating data and software – run your old PC inside your new one”

Virtualisation could ease the pain of migrating to a new laptop, and some cheap imported smartphones are worth a look

I’m going to start this month’s column with a plea from reader Andy Young, who writes: “I’ll soon be upgrading my laptop, but one of the things I always dread when I get a new PC is moving across all of my data and software from the old machine to the new one. Are there any products available that actually work?”

Well, there are a few bits of software on the market that claim to migrate both your data and software from one machine to another, and I’ve tried a fair few of them over the years with varying degrees of success, often experiencing niggling doubts about how (or, indeed, whether) they actually work. Copying documents, music, photo and video files isn’t problematic, but it’s usually email archives and certain bits of software that fail to migrate properly, if at all. This isn’t something that affects only obscure programs – I’ve had trouble getting Microsoft Office and Adobe software working after having transferred it onto a new machine.

Transferring documents across is simple – and if they’ve been synced to one of the cloud services then so much the easier – but software often needs to be reinstalled. This isn’t an issue, apart from in those cases where that favourite bit of shareware you use every day is no longer available, and you’re not in possession of its original install files. Or where it hasn’t been updated for years and now refuses to run on the version of Windows on your new machine. To save Andy from such problems, I’m going to suggest an alternative method: to run his old PC inside his new one. You may now be scratching your head, or you may have twigged that I’m talking about virtualisation.

Virtualisation enables you to run a full emulation of one computer within an application on another. It’s a great way, for example, to road test new builds of an OS without completely trashing your machine. There are various flavours of virtualisation on the market. I’ve found Microsoft’s



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“The fancier products go further still, so that besides emulating the whole PC you can also just run an individual application in a window on the host machine”

Hyper-V to be one of those products that’s utterly brilliant up to a point and then goes all “Microsoft” on you, being unnecessarily complicated. There are many open-source products out there, plus a few commercial offerings that tend to feature more bells and whistles. I’m a great fan of VMware for Windows platforms, since it works so well on both desktop PCs and the data centre; on my Macs, however, I still have a fondness for Parallels.

It doesn’t really matter which product you choose, since the principle remains the same: fire up the virtualisation system and, inside a window, it will magically “boot” up another PC, including the whole BIOS sequence. The fancier products go further still, so that besides emulating the whole PC you can also just run an individual application in a window on the host machine. The key to moving to a new PC now becomes to “virtualise” your old one, using a process known as P2V (physical-to-virtual) conversion, which makes a copy of your entire existing machine and turns it into a VM that you can fire up on the new one.

VMware offers a free download, VMware vCenter Converter, which is excellent for this task. Of course, it produces a VMware-format VM, but there are free tools available that can change this to other formats if you don’t want to use VMware’s desktop product. If you’re doing this on a business PC and you make use of virtualised servers, then you can even squirt this P2V conversion straight onto one of your ESXi hosts.

I’d suggest that you disable all network connectivity on the VM of your old PC, so that it doesn’t download any further emails and so on, or receive any OS or application updates (this isn’t a security problem, because without internet access there’s little chance of any nasties finding their way onto the VM). This ensures that the virtual machine remains locked to the exact state it was in when you upgraded. If you

want to work on a set of files, just drag them over to the new host machine. You'll be able to run any obscure, old software inside the VM, although be aware that several upgrades down the road you could end up with a Russian-doll-like sequence of VMs inside VMs inside VMs...

All that glisters

If you've been interested in technology for as long as I have, you'll almost certainly be aware of Steve Gold, whether that's from his notoriety (alongside Robert Schifreen) for the "hacking" of Prince Philip's Prestel mailbox, his work on the later versions of the wonderful *The Hacker's Handbook*, as the UK custodian of Newsbytes (that very-much-ahead-of-its-time tech news service) or for any of his many gigs writing for and editing technology and information security journals. Sadly, Steve died in January, and you can read more about his career over in Davey's column (see p118) this month.

Steve and I would often have robust discussions (they were never really arguments), mostly online and about one of his favourite subjects: cheap, imported smartphones. I'd be bigging up the latest and greatest shiny smartphone that I'd just reviewed, while he'd be laughing at people who go out and buy shiny trinkets from the big-name vendors such as Apple, Samsung and HTC. He'd insist that the handset he'd just imported from China didn't only cost a fraction of the price of the high-street models, but was more flexible too. So, as my own little tribute to "Glod", I'm devoting the rest of this column to the current state of play in his beloved "China phone" arena.

Let's start by looking at where you can actually buy these units. You could start on eBay, which has a huge listing of China phones but, as ever, make sure to thoroughly check the seller's recent feedback before placing an order. The same holds true for Amazon Marketplace sellers, as in some respects it's even more of a "Wild West" than eBay. There's Alibaba, too, which is probably best thought of as China's own version of eBay, and is a huge business. As is the case with eBay and Amazon Marketplace, Alibaba is simply

the trading platform, and you're actually buying from a vendor in another country. If you'd prefer to deal directly with a Western-friendly e-commerce company, then a couple of good options are DealeXtreme (dx.com) and Banggood (banggood.com). Both have excellent reputations and I've used them many times without any issues.

Of course, buying *anything* from China raises two potential problems: first, an extended wait of usually several weeks while your package is delivered; and second, the possibility (indeed probability) of being stung for import duties, VAT, and a handling charge from the postal service that delivers at the UK end. It's this handling charge that hurts most: I received a package recently for which I had to pay a couple of quid in duty but a stonking £15 handling charge – that's almost criminal, but if you want your goodies you have to pay up.

There's a way around this, though, since Banggood has set up an EU warehouse, which is based in the UK. You can determine which warehouse any item will be shipped from via dropdowns on the firm's product pages, and although the EU warehouse is usually slightly more expensive than the Chinese one, you'll get your items far faster, and without having to pay duty, which is definitely a win-win. If you can't be bothered to flip through the various products to find those that ship from the UK, there's now a dedicated website at eu.banggood.com that lists

only those products available here. This has actually become my new little guilty secret: where once I'd order lots of random cheap items via eBay, now I get much of it from Banggood. Just this morning the postman brought me an insanely bright LED torch that I ordered yesterday, which cost me only £8. Maybe it's just a phase I'm going through, but right now I can't stop ordering "bargains" from the company's UK warehouse!

But I digress – back to phones now. If you look on these sites you'll find a variety of smartphones: at

"Although the EU warehouse is slightly more expensive than the Chinese one, you'll get your items faster, and without having to pay duty"

the time of writing, DealeXtreme was showing around 950 Android phones in stock, and Banggood a total of 245. However, Banggood's UK warehouse had only nine, which probably makes your choice a little easier. You'll find many of them listed with a number such as MTK6582 in their model name, which is the SoC (system on a chip) version they're based on, made by MediaTek (hence the MTK). The MTK6582, for example, is a direct competitor to Qualcomm's entry-level phone chipsets, and contains a 28nm quad-core ARM Cortex-A7 CPU, usually clocked at 1.3GHz. There's also a higher-end chipset called MTK6592, which has eight cores and is pitched more against high-end Snapdragon 800- or 801-based devices.

When benchmarking MTK6592 phones, I've regularly seen them beat devices such as the Nexus 5 or LG G3 in terms of sheer grunt, while at the same time being more frugal with their battery use. Although their CPU clock speed may be lower than those Snapdragon processors, their additional cores more than compensate for this.

There are many China phones out there, but by way of example let's take a look at one that I particularly like, the Cubot X6. I'll start with the most important thing, its price. You can buy this phone from Banggood's UK warehouse for around £100-110 (the price will fluctuate due to exchange-rate differences). That's without any import duties to pay, and it includes

BELOW On one side we have a "genuine" HTC phone sold for hundreds of pounds...



shipping; you can even upgrade to first-class postage for 87p!

For your hundred or so quid, you get a solidly built phone with a 5in display that's only 720 x 1,280 pixels (so it can't be classed as "Retina" resolution), but it's perfectly serviceable. The Cubot has a 13-megapixel camera on the rear and a 5-megapixel unit on the front, 16GB of onboard storage and weighs in at 164g. While those aren't exactly flagship specifications, by the same token it's way above what you'll find at the budget end of the mainstream market. One thing I do know many of you will love is that this phone has a removable battery – something increasingly rare these days. It has twin SIM slots too (you'll find that many of these phones do), and an SD slot, something that's sadly missing from far too many current flagship phones. The only possible downside is its lack of 4G connectivity, but frankly, a lot of the 4G on offer here in the UK has now slowed down to around the same speed as 3G+, so this isn't a huge issue.

I think it's a great phone – a brilliant performer for an incredible price – but it's by no means the only player in this market. When you're looking at the various phones on offer from these Chinese suppliers, and especially at their prices and chipsets, you also need to pay attention to matters such as which version of Android they're running – at the time of writing, none of them are being offered with Lollipop (Android 5),

but the better ones will have KitKat (4.4, even better still if 4.4.2) – and also their form factor, how wide the bezel is around the screen, how heavy the device is and so on. Both DealeXtreme and Banggood publish user reviews on their sites, so scan these before making a purchase, and also do a quick Google search of the phone model and the word "review".

When sifting through the handsets on offer, you'll see some China phones that can cope with 4G, but be aware that the majority won't do 4G at 800MHz. This means you won't be able to use them on O2, and will receive only a reduced service on the other three UK networks, since they all have a chunk or two of 800MHz spectrum. You'll also notice names such as Lenovo popping up in listings – these phones aren't knockoffs, because as well as being a purveyor of reasonably expensive (and, indeed, very nice) computers and tablets here in the West, Lenovo also sells many budget phones in China. Other companies that usually produce nicely thought out products are Doogee (yes, really!), THL and, of course, the aforementioned Cubot.

It's strange how many people will talk about these China phones in a derogatory way, often forgetting that the vast majority of high-end smartphones are also made in China. Some of the high-end units are even made in the same factories as cheap Chinese imports, which is why you'll sometimes see names such as Foxconn

(one of Apple's suppliers) listed among the product names. However, I wouldn't allow this to sway your decision over which unit to buy, since it doesn't differentiate the better phones. What you should be aware of is that phones with names such as Z2, G3 and Note 4 aren't Sony, LG or Samsung devices: they'll often look a bit like the real thing, sometimes almost identical, but a quick check of their specifications will confirm that they're not – it's just someone in China playing fast and loose with international copyright law.

These cheap China phones do seem to be having an effect on the mainstream market here in the West. Many of the big manufacturers now have low-end products available at around the £100-£150 mark, but on the whole these tend to be deliberately hobbled so as not to cannibalise the sales of the higher-end handsets that you'll see in the high-street stores. As a result, such "low-end mainstream" models aren't a patch on the better China phones. Another recent twist to the market is that the Chinese have now started to introduce their own high-end branded products, the most notable of which is the OnePlus One (the OnePlus Two should be out in the next few months).

In case you haven't heard the noise surrounding this manufacturer, the One is a great device, available at a bargain price (£270 for a high-end phone with 64GB of storage). Not quite as low as other China phones, but about half the price of a similarly specified flagship handset from one of the big brands. At the time of writing, you need an invite to buy a OnePlus One: in fact, I receive emails and tweets from readers almost every day asking if I have any spare invite codes – sorry, I don't. I was planning to write about the OnePlus One this month, but changes afoot and it appears that the manufacturer may be about to change the flavour of Android that it uses on the phone, so if all becomes clear by next month, then I'll write more about the phone in that column.

In the meantime, I'd encourage anyone thinking of upgrading their phone (or perhaps just looking for a spare) to check out these China phones. Once upon a time, they could be a bit iffy and a somewhat risky purchase, but now there's much to commend and being able to buy them from a UK depot makes it a no-brainer. Steve Gold was right after all, and I just wish he was still around so that I could tell him.

@PaulOckenden

"These cheap China phones do seem to be having an effect on the mainstream market here in the UK"

LEFT ...and here we have a remarkably similar Cubot X6, costing just over £100



ROGER CAREY

“While we all agree what a bit or a byte is, we seem to have no definitively accurate tool for measuring them”

When is a gig not really a gig? It's no academic question when you're an ISP setting a download limit, but the answer is tricky to nail down

“How much? I can't possibly have used that much!” These are words we often hear at the end of a month, when we reveal to our rural wireless-broadband subscribers the amount of bandwidth they've used.

Here at Village Networks, we encourage our subscribers to conserve bandwidth. We explain that it's a limited resource, and that our ability to provide equal access to all our subscribers relies on everyone's adherence to the agreed allowances.

A truth of ISP management is that the faster the connection, the more users will download. With 2Mbps/sec, it isn't worth trying to watch anything from Netflix. With a 24Mbps/sec connection, you can watch two Netflix movies, over the same connection – and if you can, you will.

So, as we've followed market forces and upped our connection speeds, we've also seen significant growth in download volumes. Currently, 85% of our subscribers still meet their entire internet needs with a 60GB monthly download allowance – average use is around 20GB. The other 15% have unlimited hunger, and that proportion is growing.

BT has around 7,000,000 broadband subscribers; Village Networks has around 1,000. Much as we'd like to offer unlimited use across the majority of our network, this simply isn't possible. So our subscribers have a choice: breach your monthly allowance and accept a temporary speed restriction, or agree to pay extra.

It's hard to avoid the feeling that some otherwise quite tech-savvy subscribers are trying it on. “It wasn't our fault. There's a problem with our smart TV. It downloads movies even when it's switched off.”



Roger is the chief marketing officer for Village Networks, supplying rural broadband connections where BT can't

“Over a typical four-week period, we found a difference of 35% between the smallest and largest total”

BELOW Our results from testing four bandwidth monitors show huge discrepancies

Other users, however, can be genuinely perplexed by the amount of bandwidth they get through. And while we can supply them with a figure of use, we can't provide the details they crave – was it really that much? When did I use it? Was it on the desktop or the iPad?

A second opinion

At Village Networks, we're cautious about recommending third-party software and apps. They're not ours. We can't take responsibility for them, or provide support for them. We already spend enough time winking out spyware and adware, worms and trojans from subscribers' PCs. This isn't what an ISP should be doing. But we're a caring and service-driven bunch, so when we have to tell a subscriber that they've exceeded their monthly allowance, it seems harsh to simply say “that's what our monitoring systems say, so tough”.

We thought it would be helpful to suggest some third-party bandwidth monitors. These would let customers track for themselves, if not where, then at least when their download traffic is peaking.

We decided to carry out an appraisal of some of the bandwidth-monitoring software that's already out there. We were looking for something that was free, and easy to install and use; something that would

display the data in a format that could be easily understood.

Our findings surprised us: we saw significant, haphazard, inexplicable variations in measurements. The differences, on any given day, were of as much as 100MB.

We've been testing FreeMeter, BitMeter, NetWorx and tbbMeter. (There are others we haven't yet tested, but there are only so many hours in the day.) They're simple and run themselves in the background – except FreeMeter, which usually seems to uninstall itself whenever it's closed or a device is rebooted. Stack them up with their impressive graphic displays in vertical alignment, and as the bar charts track from right to left, the spikes and troughs appear to march in reassuring unison.

However, as the data accumulated (see table below), something didn't seem quite right. On a typical day, 5 November 2014, the software displayed the following results: FreeMeter 27MB; BitMeter 27MB; NetWorx 14MB; and tbbMeter 14MB. Although the first two agree roughly, as do the second two, the difference as a proportion is huge. And it's much more than can be accounted for by the difference, say, in bits and bytes.

Concerned, we ran comparison tests over three machines, two running Windows XP, one running Windows 7. Our usage models ranged from heavy multimedia business use to my 93-year-old mum on Skype and email only. We found similar random discrepancies.

We began testing in October, and continued until the end of December. At the beginning of the project, we didn't plan to test for that length of time, but since the big discrepancies kept appearing, we felt a duty to continue.

Over a typical four-week period, we found a difference of 35% between the smallest total and the largest: 7.3GB reported by tbbMeter, and 9.9GB reported by BitMeter. Something wasn't right.

Some of the software is machine-resident and some of it is server-based. BitMeter's totals quite closely match those of FreeMeter; tbbMeter's results have a broad similarity to NetWorx. But how can one explain the difference between the results on, say, 26 October or 20 November?

The differences tended to be greatest among the smaller numbers. But even on the heavy download days, while there appears to be better agreement, there's still no consistency or pattern. When compared with the

Date	MB downloaded			
	BitMeter	tbbMeter	FreeMeter	NetWorx
20 Oct	783	701	760	774
21 Oct	290	233	280	248
26 Oct	145	37	140	40
27 Oct	226	115	220	123
28 Oct	641	286	641	299
03 Nov	102	60	102	25
10 Nov	735	318	727	347
20 Nov	117	23	117	26
01 Dec	123	75	110	83
02 Dec	634	587	634	619

spread of results in our tests, our own metering – resident on the system routers – comes out on the high side of the middle. It's integral to our network, so we regard it as definitive.

We raised the question of wild discrepancies with tbbMeter's sponsor, Thinkbroadband. The response was sensible – is tbbMeter measuring LAN traffic as well as the host device's internet traffic? The answer was no. And tbbMeter tends to produce lower totals than its peers, anyway. But neither were any of the other monitors counting any traffic other than that from the host machine. How can we be sure? Well, fetching a 10GB download on each of the other machines on the network and seeing no acknowledgement of that in the monitoring software is pretty good confirmation.

While we can say some monitors produce similar results to others, and some match our own measurements, we can't say which is accurate and which isn't. But this isn't the issue.

Measuring for size

The issue is this: we ask people to pay for their bandwidth by the GB. What happens when Village Networks says, "you've just downloaded 75GB", and the subscriber's own measurement software says they've downloaded only 50GB?

If the man on the fruit stall sells us a kilo of apples, it had better be a kilo, or he's in trouble. Gas, water and electricity meters are calibrated and certificated. But, while we may all agree what a bit or a byte is, and how many there might be in megabyte and a gigabyte, we seem to have no definitively accurate tool for measuring them. I don't suggest that the authors of current software are incompetent, or mischievous. But it's clear that they're not all measuring in the same way, or with the same precision.

There's a second problem. Software installed on a device only measures the traffic to and from that device. Nowadays – as we so often have to remind subscribers – it isn't only the desktop that's munching through bandwidth; it's the laptops, the tablets and the smartphones too. For those with home offices, it can even be the email-capable printer. And does the Wi-Fi-connected



camera automatically update its OS twice a month?

You see our point? For a clearer picture of the numbers, measurement should be via a router. Indeed, SNMP-enabled managed routers do have this capability. Most Cisco routers have the NetFlow analysis tool built in, but managed routers aren't often available at home-network prices, and unless mum or dad is an experienced sysadmin, it's probably best not to try actually managing the managed router. A typical home user doesn't want to get involved, and usually can't get involved, in fiddling with router firmware, or setting up IP packet-sniffing technology.

Even if there were a home-priced router that could report on which

ABOVE At first glance, the peaks and troughs measured by different software appear the same – but that's not true of the total data "downloaded"

BELOW Village Networks would like to see a standard set for accurately monitoring data usage

device did what and when, could we be certain that the total gigabytes downloaded would agree with any other brand of router? Or, indeed, with the ISP's meter? So far, all the signs point to the answer being no.

In our very simple tests, we compared only four of the most commonly used monitors. There's a handful of Windows OS bandwidth monitors out there, plus apps for iOS and Mac devices, and Android devices too. Are they all calibrated to agreed standards? If they're measuring paid-for use, shouldn't they be certified? And shouldn't a requirement of certified calibration apply both to the supplier and the subscriber?

Although backhaul continues to get cheaper, we're still a long way from universally unlimited broadband. Until that time, there's a need for accurate measurement to agreed standards.

In the meantime, I'm waiting for the day when our local Trading Standards office SWAT team arrives to inspect our byte-counting software, in response to a formal complaint that a subscriber's software doesn't agree with ours – and asks us what we propose to do about it?

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DAVEY WINDER

“There have already been real cases of baby monitors being hacked into for spying purposes”

Wireless technology opens up a whole new threat to hacking; knowledge is key if you're to avoid being the victim

The Internet of Things (IoT) has opened up a new can of insecure worms, a subject I've commented on before (see [pcpro.link/247iot](#)). The usual response is that the threat of devices such as smart power meters becoming vulnerable to back-door attacks – or clever heating thermostats being ramped up to create National Grid havoc – is merely alarmism, a kind of science fiction. However, the fact is that there have already been real cases of baby monitors being hacked into for spying purposes, and connected cars becoming liable to interference by remote hackers. Tim Rains, Microsoft's director of cybersecurity and cloud strategy, has stated that, “some of these devices lack basic security capabilities, while others have security capabilities but they're inappropriate for all the scenarios that the device can be used in.” Microsoft is committing to making IoT security a priority as a result.

But there are some threats that aren't new, and they're not being taken as seriously as they should. Most people are at least aware of the risk inherent in using free, unsecured wireless internet in public places, but how many are concerned with wireless-keyboard insecurity? The notion of keyboard insecurity itself isn't new, and the threat is pretty obvious: “keyloggers” have been around for some time. Indeed, I was using a home-brewed one to capture keystrokes and hide the output inside image files (using steganography) some 20 years ago to great effect. In my days as a hacker – as in “explorer of networks” – this trick enabled me to access the online accounts of anyone who used my computer while visiting my home, and that included sysadmins who should have known



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“Using a wired keyboard would eliminate the risk he was worrying about”

BELOW The KeySweeper device has exposed the wireless keyboard security risk you didn't know existed

better. That kind of technology went on to become part and parcel of the hacking scene, and continues to be used today (minus the steganographic shenanigans) by cybercriminals to grab people's logins. Internet security systems are well aware of it and have plenty of measures in place to prevent such threats, with more clued-up transactional services using virtual keyboards as a defence against this method of attack.

I started thinking about capturing key data from a wireless keyboard after a client asked me whether some new hardware he'd seen advertised was worth the not-inconsiderable investment: a “secure keyboard” that retailed for almost \$200 in the USA. It was a wireless model that employed 128-bit AES encryption, alongside a USB nano-receiver to ensure all communication between host computer and keyboard was encrypted. It did have a few positives, such as a ridiculously over-specced 1,600mAh battery that promised half a year from a single charge, and I approved of its mechanical key action, but as to whether my client actually needed such a keyboard, my answer had to be no.

He didn't really need a wireless keyboard at all, and using a wired one would eliminate the risk he was

worrying about (and he'd only started worrying after reading marketing material for that secure keyboard).

I pointed out to him that the risk was minuscule in the real world since wireless-keyboard signals are notoriously weak, so a hacker would need to be in the same room to intercept those signals. There's the laptop-in-café scenario, but who uses a wireless keyboard with their laptop? Most major keyboard manufacturers actually build signal encryption into their products, rendering a more expensive keyboard redundant. So I advised against this unnecessary expenditure, and then forgot about the potential for wireless keyboards to become risky – until now.

The reason for my memory jerk is a rather clever and worrying device called KeySweeper, which for less than £20 introduces a new risk to the keyboard-capture equation. KeySweeper is the proof-of-concept brainchild of security researcher and hardware hacker Samy Kamkar ([twitter.com/samykamkar](#)). It employs readily available Arduino-based components to create a “functioning USB wall charger that wirelessly and passively sniffs, decrypts, logs and reports back (over GSM) all keystrokes from a Microsoft wireless keyboard in the vicinity.”

Data-logging USB chargers first came to my attention during the football World Cup in Brazil, when reports circulated about such devices being deployed in airport and hotel lounges to grab data from connected devices. However, this was the first such wireless-scanning device I'd seen designed to connect to any wireless keyboard in the vicinity (not only Microsoft) and log all its keystrokes to internal flash memory, then transmit these logs remotely via GSM. Samy notes that the GSM

module will trigger SMS alerts on certain keywords, such as usernames and URLs, which then recall the stored passwords – clever stuff. Actually it's all very clever, from the simplicity of the Arduino microcontroller at its heart, to the internal battery that enables it to keep scanning and collecting even if someone unplugs it from the wall, then recharges when next plugged back in. The most worrying part, though, is the low cost for which it can be constructed, which makes it something of a fire-and-forget disposable device for determined hackers.



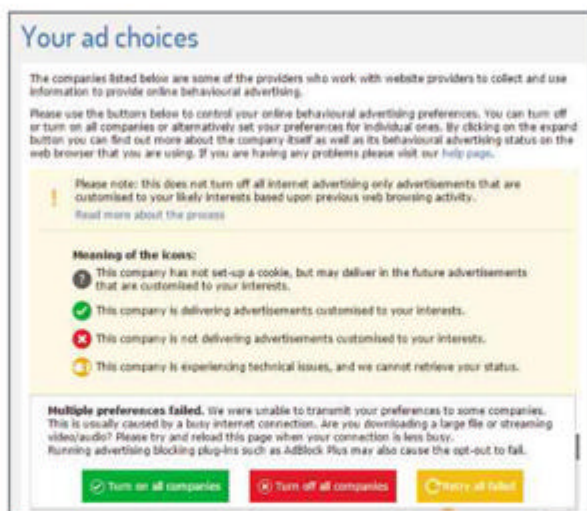
If you want to see exactly how Samy built the KeySweeper – and understanding how such devices work is essential to protecting yourself against them – then head to samy.pl/keysweeper.

Its Arduino microcontroller is partnered with an nRF24Lo1+ radio-frequency chip, modified by Samy to get around its limitation of only really being meant to communicate over proprietary protocols. This is achieved by use of an XOR algorithm to encode keystrokes against the keyboard's MAC address as a key: read that MAC address over the RF chip and you're only a step or two away from decoding the data. Samy chose older (pre-2011) Microsoft keyboards as his target, since the first byte of their MAC is always the same (oxCD), which makes decrypting keystrokes even easier. Microsoft points out that it does sell keyboards made after 2011 that use AES and so aren't vulnerable to the technique, and none of its Bluetooth-enabled keyboards can be sniffed this way.

My main advice to my client still stands: if you don't absolutely need a wireless keyboard, then why introduce the risk? Unfortunately, my forays into business premises – from the smallest start-up to the largest enterprise – inform me that the trend is towards wireless everything, and so my reluctantly modified advice is that if you have room for a wireless USB nano-receiver, then you have room for Bluetooth; Bluetooth wireless keyboards are far more difficult to crack (although not impenetrable). And if you really must use a 2.4GHz keyboard, at least check that it employs some form of AES signal encryption out of the box.

Facebook's stupid ad policy

Someone recently suggested that Facebook is like Marmite – you either love it or hate it – but I think it's actually more like Radio 4; sometimes it's annoying, but you can't live without it. However, unlike Radio 4, Facebook carries advertising, which is the cause of much of users' annoyance. Not the ads themselves so much as the utterly pathetic way in which they're targeted. Facebook goes to great lengths to try to help advertisers create campaigns that



reach their intended audience, so why is it missing by a country mile?

Surely I needn't provide examples of how irrelevant Facebook ads can be, as we've all seen plenty of them in the sidebar or inserted into our News Feeds? Sometimes the dissonance is the advertiser's fault, since they don't appear to realise that broad sweeps are less effective than fine brushstrokes when it comes to selecting their audience. Sometimes it's the user's fault for disabling options in the name of privacy that might give advertisers' shots a clearer aim. Most of the time, however, it's just Facebook being dumb, and thankfully there are several options available to counter this madness.

First, you need to understand how Facebook determines who sees what, which in essence revolves around the information you share, the information provided in your profile, and the information advertisers have gathered about you from websites besides Facebook. Luckily, you do have some control

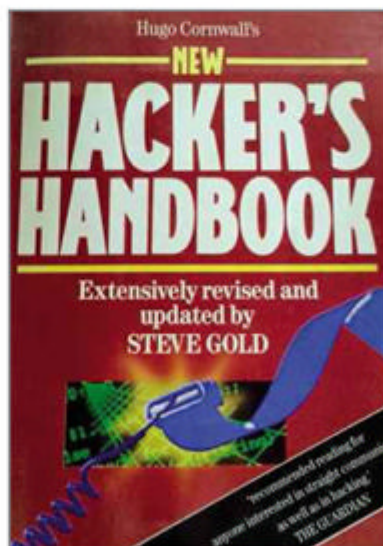
over all of this data, and that begins by you clicking the top-right corner of an advert and telling Facebook you don't want to see it. This should remove you from those audience groups, thereby refining the ads you do see. You can also opt out of advertising based on website usage from companies that participate in the relevant

ABOVE Take ad control back from Facebook

BELOW Steve Gold, aka Glod: RIP



BELOW The Hacker's Handbook propelled me into the world of network exploration



schemes by visiting youonlinechoices.com/uk. The best advice I can offer, though, is to filter them out by using software such as Adblock Plus and Social Fixer, which do a good job of making most Facebook ads invisible to me.

Glod: an information security legend

Steve Gold, who sadly died on 12 January 2015, days before his 59th birthday, was more than just a veteran security journalist and pioneer hacker – he was my friend, mentor and inspiration. It's no exaggeration to say that were it not for Steve (known as "Glod" to many) and his partner-in-crime Robert Schifreen (aka "Hex"), I wouldn't be writing for *PC Pro* today. Steve and Robert, you see, were instrumental in getting me interested in network security and hacking.

I used the term "partner-in-crime" but the truth is, back when this pair successfully hacked into the personal message box of one Prince Philip while "exploring" BT's Prestel Viewdata service at the end of 1984 and start of 1985, hacking really was a case of system exploration minus the malicious intent. Many of us old farts of online technology journalism cut our teeth on dial-up systems such as Prestel, Micronet, FidoNet and CIX, which served a similar role to Facebook before the public internet explosion. Indeed, the true definition of a hacker was (and remains) someone who wants to find out more about a technology, be that hardware, software or network.

Ultimately, the police got involved after the hack was disclosed to Prestel, but they struggled to find anything to charge them with since hacking wasn't illegal at the time. Instead they were charged under section 1 of the Forgery and Counterfeiting Act 1981, accused of defrauding BT. Long story cut short: both were found guilty of several specimen charges and fined. The verdict was appealed and Alistair Kelman (whom I also now consider a friend) successfully got them acquitted, an acquittal that was upheld in 1988 after the prosecution appealed to the House of Lords. At the time it was concluded that hacking wasn't illegal under English law and that new legislation would be required to make it a criminal offence – hence it was in response to the activities of Glod and Hex that the Computer Misuse Act of 1990 was introduced.

Steve went on to pursue a career in journalism, but it was his role in the

Continued from previous page

Prince Philip hack that first grabbed my attention, soon followed by his account of the affair when he edited the fourth edition of *The Hacker's Handbook*. This book, written by Professor Peter Sommer under the pseudonym of Hugo Cornwall, had been regarded as the hackers' bible for a few years, and the addition of Glod as co-author for what became its fourth edition was a masterstroke. It was the book that not only inspired me to explore networks for myself in the late 1980s, but it also served as my technical roadmap for that exploration.

As security journalists, Steve and I followed similar professional paths, although Glod with far more success. As well as spending many years as a fraud investigator for the NHS, Steve had been instrumental in launching the Newsbytes News Network. He helped launch *PC Dealer* in 1989 before becoming its editor a few years later, and also co-founded the first dedicated IT security publication, *SC Magazine*, in 1994. Ten years later he joined *Infosecurity Magazine*, where he ended up as Technical Editor. At the time of his death, Glod was running an arts shop, helping write press releases for a PR company, and editing *Lawtech Magazine*.

Steve's understanding of the infosecurity landscape was immense, and he possessed the same level of knowledge when it comes to mobile phones (see *Paul Ockenden's column for details, p114*) and didn't keep it to himself. I realise it was his job to write about his knowledge, in the same way I try to, but Steve would share with anyone who asked. He was always happy to help out PR folk, the security industry itself, even little old me, regarding anything with which we were having problems. I'd often turn to Steve for technical advice when I got out of my depth, and he'd always oblige with a smile and stunningly accurate information, no matter how busy he was at the time. Glod, I shall miss you – and the data-security world will be poorer without you in it.

Find out more about Steve Gold at the Silent Modems memorial site (silentmodems.com).

 davey@happygeek.com

STEVE CASSIDY

"The idea wasn't some imposingly academic brain-bender, but that Big Data has arrived in HPC land"


A trip to Cambridge's high-performance computing facility offers up a tear-jerker from the field of computational genetics in medicine

And so to Cambridge, the hoar frost fresh upon the withies beside the track from Liverpool Street station. There's something about visiting an 800-year-old institution by train that makes me think of powdered wigs, clay pipes and quill pens, and while I realise that's a heap of anachronisms bundled into a foggy overview, that's actually my point. Eight-hundred years of deep thinking is the hallmark of a federated mass of colleges, and their approach to information technology can't remain immune to this effect. So how was it that a single professor's presentation led me from high-performance computing (HPC), InfiniBand and gamers' graphics cards, right through to the pathos and high drama of sick children, family breakup and ruined lives?

This trip to Cambridge was all about supercomputers. Back in the day, a supercomputer was just an XXL-sized mainframe, heavily sprinkled with LEDs that couldn't possibly keep up with all that was going on within the beast's liquid-cooled guts. This remained the common perception of high-end computing for decades, and if you listen to the guys who founded the original Cambridge HPC Service (HPCS), it was they who took the brave leap by moving away from this manufacturer-blessed approach towards deploying "commodity hardware" – that is, top-end versions of PCs, much like those we use to run our businesses if we can justify such CPU-heavy configurations.

I realise that to many people the word "commodity" always implies "unbranded, build it yourself" – with the further implication that this is the road to a cheap architecture – but whenever I visit people who talk about this kind of architecture, I invariably discover that their definition of "commodity" stops short of that evangelists' dream. One such client ran web spiders on



Steve is a consultant who specialises in networks, cloud, HR and upsetting the corporate apple cart
 @stardotpro

"The amount of data used by HPCS customers has gone up by 100 times since 2010"

Dell Vostro desk-side boxes, because they wanted quad-core CPUs and a middling amount of memory, with a reasonably sensible swap-out maintenance contract that fitted with their reload/recommission/rerun cycle. A full-scale server rack might have failed less often, taken up less floor space and looked better in their brochure, but while they couldn't justify the spend on a full-blown data centre, neither did they want to take the risk of actually wielding their own screwdrivers.

Cambridge HPCS has shifted this decision point further up the price/performance curve: they're not afraid of screwdrivers, of course (as the inclusion in Professor Ron Horgan's slide deck of Maurice Wilkes working on the world's first general-purpose computer in Cambridge in 1947 amply demonstrated), but the reason we journalists were invited there at all was that the latest iteration of their HPC cluster is furnished by Dell and contains a lot of accelerator cards developed by Intel.

The odd thing about this project is that while the initial assumption has that "commodity" tag written all the way through, the actual implementations are remarkably restrictive. You could, in theory, choose to go with a complete ragbag of heterogeneous PCs, all running OpenFOAM (assuming your HPC job is about 3D modelling – although not all are) and linked together via Ethernet, but then your results would depend on the completion of this mongrel network's slowest member, and the ability of said network never to drop a single errant packet. Those who need to do week-long runs on vast quantities of both data and calculation prefer to rely instead on fully tested and technically specified InfiniBand networks, connecting cluster members, controller members and storage resources; and while InfiniBand isn't proprietary, it's hardly "commodity" either.

Making the numbers count

Anyway, to be honest, I wasn't all that interested in the exact specification of the stack of kit that makes up the HPC cluster at Cambridge – it contains around 9,600 cores, uses Intel expansion accelerator cards (not Nvidia CUDA) that, along with the main CPUs, the InfiniBand hardware and the basic OS, are all installed inside Dell servers that you can buy off the shelf.

The funny thing was that, despite this being an event hosted by IT businesses selling CPUs and system speeds as their distinguishing factor for years now, this wasn't what took up most of the presenters' time. Dr Paul Calleja runs the HPCS these days, and he set what I consider to be a very Cambridge tone by chuckling over how easy it was to demonstrate a major trend simply by re-inserting some old slides from a previous presentation. (Worryingly, for me at least, he considers 2010 to be "old" in HPC terms.) And the takeaway idea wasn't some imposingly academic brain-bender, but rather that Big Data has arrived in HPC land.

While the amount of data used by HPCS customers has gone up by 100 times since 2010, the amount of CPU power squeezable into the HPCS's departmental budget has increased by only ten times, and against the background of some truly astounding increases in speed and bang-per-buck. I wondered whether this also had something to do with post-crash austerity, but from the various figures being bandied about, and the stories of cross-connections between academia and everyday industry, I suspect that the HPCS team can find extra cash – but only when it's absolutely confident it can show a speed increase by spending it. The HPCS definitely earns its keep nowadays. Far from those disciplines that have traditionally pursued heavy-duty compute power – pure maths, particle physics, meteorology and cosmology, for example – the majority of the clients Calleja sees may not require such long runs. However, they do bring with them a shed-load of data – and biology is the leader of the pack.

The main thrust of Professor Willem Ouwehand's presentation didn't dwell much on terabytes or hours of runtime while introducing the application of HPC as a resource in biology: rather, he explained the scale and nature of the problem of rare, genetically caused diseases. Of the 800,000 babies born per year in the UK, around 40,000 have a disease that's caused by a transcription error in DNA or a poor genetic match between the parents. Recently there's been a rash of disappointed science pundits who look at such genetic flaws, then turn to look at the Human Genome Project and complain bitterly that public money (actually it's charity money, but hey) is going to waste on a fool's errand. Not Professor Ouwehand.

Rapid genotyping of the entire genome – the Americans apparently only go in for selected subsets – then collecting samples from those diagnosed with rare diseases, is very likely to deliver huge, genuine benefits, with direct savings for both the NHS and everyone involved with the care of a sufferer from a rare disease. Ouwehand showed an infographic from the Shire group to get this point across (see below).

Professor Ouwehand also showed us how hungry this genotyping is for

"A cloud resource of rare-disease diagnostic Q&A could usefully shorten the time taken for a diagnosis"

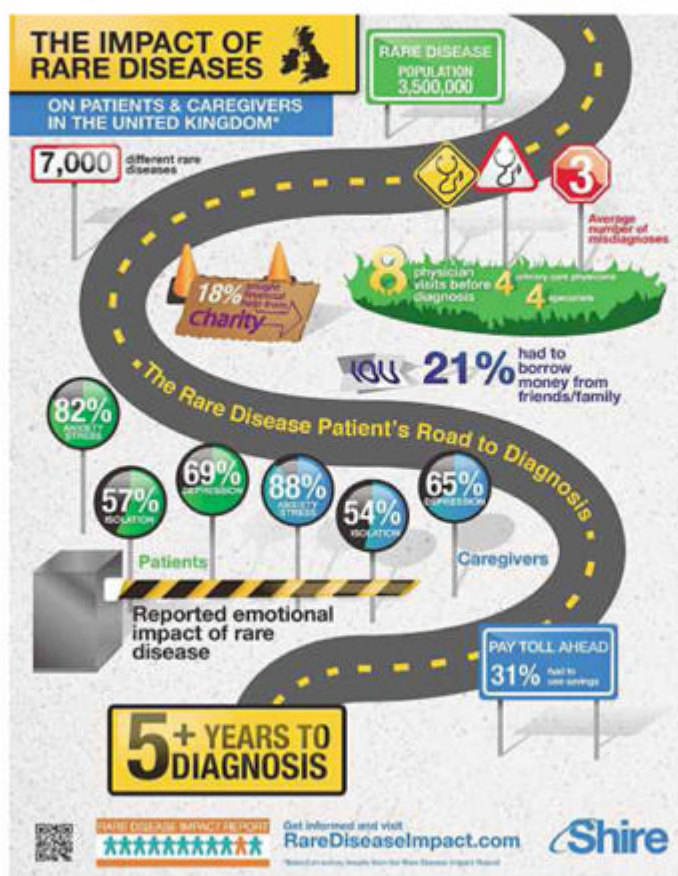
BELOW High-performance computing could help with the diagnosis of rare genetic diseases

HPC power. Quite simply, the nature of rare genetic diseases is such that, on average, diagnosis takes something like five years for your standard, unassisted human doctor to complete. This isn't a matter of "must try harder" or "could be better with a few more quid to spend"; it's an inherent and intractable limitation of the process of diagnosis as it's performed today. Ouwehand painted a picture, made possible by 2015 performance levels in HPC clusters, which gives doctors access to a cloud resource of rare-disease diagnostic Q&A, thereby usefully shortening the time taken for a diagnosis.

One statistic he delivered – which wasn't on that Spire infographic – is that by the time a child's diagnosis of a rare disease is complete, 50% of the parent couples have divorced. Now make no mistake here: genomics is about rapid identification of such a disease, not about curing it, and it's arguable whether the cause of a couple's split was the baby's sickness, the delay in bureaucratic processing or the guilt stemming from such imperfection. Regardless, there's no doubt that it's worth striving to reduce that five-year diagnostic task – with an average of eight specialist visits and who knows how much GP time – for syndromes that might be far more easily handled once correctly identified.

The hardware that's being used for this grunt work – the sequencing and pattern-matching of genetic material and the cross-correlation with patient complaint and treatment records – isn't all that "commodity": it's a room full of standard servers and several rooms full of spinning disks, hosting specialised datasets ready to be delivered to superfast, generalised hyper-speed compute resources installed closely to small caches that help with queue management. This architecture exists because, in the noughties and before, the games industry focused so keenly on the expansion architecture of the IBM PC platform as its best hope for better game performance. In particular, it focused on the highly commoditised graphics card as the best place to hide all the ultra-high-speed processing power, so that gamers could boost speeds without having to throw their whole machine away.

This is the market that gave rise to CUDA, and hence to huge amounts of available CPU power that far outstrip most people's daily graphical needs – and without the competitive



pressure of the graphics card vendors all aiming for higher benchmark scores, there wouldn't have been enough teraflops available to the HPC system designers to address problems such as the one posed by the genomics of rare diseases.

So when you hear someone burbling away about the misspent youth of spotty gamers, and the terrible influence of first-person shooters on the fabric of modern society, ask them how many years they'd prefer it to take for a diagnosis of familial hemiplegic migraine or craniopharyngioma to be finalised – because the excesses of the first group appear to have driven the rapidity of help for the other.

One step up in Wi-Fi

Let me step a little carefully here. In all the places I visit – and I really do mean all of them – I encounter a specific make of DSL router and Wi-Fi base station. It's a brand that's been around for years and clearly attracts immense loyalty and customer engagement, with almost every *PC Pro* reader in each business I see having nothing but praise to heap upon it. How any entrepreneur can get their customer base to feel so engaged with a cheap plastic box adorned with a few poorly aligned LEDs is a mystery to me. It definitely works, though, and I learned pretty quickly not to criticise this DSL: casting aspersions on its software architecture or the code quality of the firmware in this particular model was never the right way to kick off any client relationship or any Business Clinic visit.

It took time for me to separate cause and effect in this matter – that is, both for my own dislike of the whole range and for the loyalty to it I kept encountering. Eventually the penny dropped: almost nobody I was meeting really felt they comfortably understood how to relate the way IPv4 worked inside their network to the way that their ISP made IPv4 deliver internet traffic to their network. Especially at the

lower reaches of the marketplace, the apparently hard-and-fast rules that you'll read in the usual Wikipedia pages, original RFCs and other (allegedly) canonical resources just didn't seem to be applied by internet access companies. Traceroute reports with packet paths jumping into and out of private range networks; ISP hardware device addresses outside the subnet you're told to use as your own; multiple subnets displaying radically different hop counts to reach the same targets: the list of their transgressions is as long as it is incomprehensible.

Quite a lot of you, dear readers, have taken the view that arriving at a full understanding of such nonsense wasn't a business-critical activity, and so you plumped for a router that reflected the mysterious nature of these peculiar connections by not implementing the standard presentation of a device worthy of the name "router" at all. This is the type of device that fudges the distinction between inside and outside the network, and hence makes it difficult to establish whether what you're doing to move special types of traffic is actually full 1:1 NAT or selective port forwarding. And this is why an entire market sector has convinced itself that networking is difficult, and that pricier networking products are therefore going to be complicated. My own experience and conviction is that nicer networking products make your life easier, not harder.

Of course, if you've hacked your way into making something work reasonably well using a super-cheap ISP contract, then the first thing a more expensive and more standard device will do is fail to work over your connection, since that connection won't meet its standards-defined needs. Most often my input in this situation is to run a few demos that show how climbing just a couple of



ABOVE The ZyXEL NXC2500's basic-looking box hides a top-quality software platform

rungs up the spending ladder can deliver huge benefits that aren't obvious from a vantage point way down at the bottom.

One recent example I've been playing with quite frequently is the ZyXEL NXC2500. Take a look at its specification at pcpro.link/247net and the photo to the left.

I know what you're thinking: that looks just like those basic devices that ZyXEL sells into the same market as my unnamed router vendor. Indeed it does, but the moulded plastic of its case is no guide to the quality of the software inside. Perhaps the best guide to that is the physical weight of the unit; this isn't a mostly empty plastic box with a tiny PCB in one corner, nor does it limit itself to a single function of brokering a public and a private network as cheaply as possible.

A careful reading of its feature set is a good way to understand how the issues that often confront a network manager in a small business can be met without driving a coach and horses through compliance with the standards. However, I have to be honest and say that those parts of the system that concern themselves with operating as a mesh of controllers inside a VLAN, to fully segregate a multi-access-point Wi-Fi fabric from the business network it's obliged to share wires with, are every bit as confusing as the config shortcomings in my least favourite router brand.

But the core point in this argument is that such confusion is productive. Unlike the first type of confusion, which misrepresents IPv4 and wide-area-traffic setup as a black art with no way out, the kind of environment you can work with inside a properly thought-through device such as the NXC2500 (or some of the bigger TP-Link models, or the Netgear Professional range of routers and gateways) makes it easier to understand the thinking behind the architecture of the standards, not more difficult.

I realise that sharing this aperçu might not directly help my own revenue stream: ideally, I should be proposing the least comprehensible platform I can find, so that I can arrive via the window in a swirling cape and wizard hat. But really, it's now 2015, and routers whose software platforms remain largely unchanged since the 1990s need to be put into a cupboard and left there – not looked upon as vital, untouchable parts of your business.

 cassidy@well.com

"Nobody I met had understood how to relate the way IPv4 worked inside their network to the way their ISP made IPv4 deliver internet traffic to their network"



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We explore the trends and technologies that are set to shape the future

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Geek Day Out
Classic gaming and more at the National Media Museum **p128**

Broadband from space: the race to satellite internet

Elon Musk and Richard Branson are squaring off in low Earth orbit as they battle to deliver broadband to the world. **Nicole Kobie** explains



Here's how to annoy rural Britons: give Martians faster broadband access. Elon Musk, the forward-looking mastermind behind SpaceX and Tesla electric cars, wants to build a satellite internet system that could reach Mars – and he has competition from Richard Branson's Virgin Media.

The idea may sound crazy, but broadband networks have taken to the skies of late, with Google testing connectivity via weather balloons and, along with Facebook, investing in internet-delivering drones (see *Broadband by balloon, opposite*). Here's how the new breed of satellites will deliver broadband from space.

■ Improving satellite internet

Satellite internet already exists, but Musk's proposed system is different: it would use thousands of micro-satellites, around ten times as many satellites as Iridium's network – currently the largest in the world.

Each of Musk's satellites weighs around 113kg, less than half the mass of standard satellites, which orbit at a 35,000km height. The new satellites will be launched into

low Earth orbit, which is only 750km from the surface of the earth. That will improve latency, a major challenge with existing satellite internet: from low Earth orbit, latency is predicted to be around 30ms, compared to the typical 500ms latency experienced by existing satellite internet customers.

Micro-satellites also cost less: \$350,000 to build and launch, as opposed to the tens of millions of dollars of larger ones. Getting them into space is another issue, but both Musk's SpaceX and Branson's Virgin Galactic are working on cost-effective ways to deliver payloads into orbit.

■ Space race

At the start of 2015, Richard Branson announced that Virgin was working with Qualcomm and OneWeb to build such a network, using its own Virgin Galactic launcher programme.

"We have the biggest order ever for putting satellites into space," Branson said at the launch of the project. "By the time our second constellation is developed, the company will have launched more satellites than there currently are in the sky."

Key to that system is OneWeb founder Greg Wyler, who many expected to work with Musk on his satellite internet plans – not least because the pair are close friends. However, Wyler has signed up to work on Virgin's competing project.

"Greg and I have a fundamental disagreement about the architecture," Musk said in January. "We want a satellite that is an order of magnitude more sophisticated than what Greg wants. I think there should be two competing systems."

Branson disagreed. "Greg has the rights [to spectrum], and there isn't space for another network – like, there physically isn't enough

LEFT Elon Musk and Richard Branson are in a race to deliver broadband from space



Internet drones

Facebook is turning to drones to deliver internet around the world – but these won't be toy-like devices. Facebook expects them to be the size of 747s and fly for years at a time. Like Google's Project Loon balloons (see *Broadband by balloon, below*), they'll take to the air above commercial aircraft and weather.

Yael Maguire, engineering director at Facebook's Connectivity Lab, told a Mashable conference that the company hopes to test its internet drones in the US this year, but it's also looking at other countries. To help it achieve that, Facebook last year bought Ascenta, a British firm that holds the record for the longest-flying solar-powered drone. It expects to have the planes delivering internet connectivity within three to five years.

Facebook isn't the only company looking at internet drones: alongside its own Project Loon and investment in Elon Musk's satellites, Google has



acquired Titan Aerospace, which makes solar-powered drones. Titan's unmanned craft have a wingspan of 50m and fly at an altitude of 65,000ft, and the company has previously said it will be able to deliver 1Gbit/sec speeds at some point in 2015.

space," he responded. "If Elon wants to get into this area, the logical thing for him to do would be to tie up with us, and if I were a betting man, I'd say the chances of us working together rather than separately would be much higher."

Work on the two projects is only now ramping up: with both reportedly on hiring sprees, now is a great time to be a satellite engineer. Musk expects the final project to cost \$10 billion, and he's already won \$1 billion in investment from Google and Fidelity Investments, although his system will take at least five years to become operational.

■ Broadband for the masses

Despite the costs, Musk believes the space network could pay off, seeing it as potentially funding work even further afield. "We see it as a long-term revenue source for SpaceX to be able to fund a city on Mars," Musk said at a SpaceX event in January. "It will be important for Mars to have a global communications network as well. I think this needs to be done, and I don't see anyone else doing it."

Closer to home, the networks – as well as broadband connectivity projects using balloons and drones – are designed to bring online the three billion people around the world who are yet to get internet access.

IHS iSuppli analyst Ian Fogg sees this as the "connecting seam" between all of these extreme-sounding projects. "Today, connectivity and access to the net is as important, or becoming as important, as having power or having access to food and water," Fogg said. "It's becoming a utility that's important, if not essential, for regular society and the economy... And that's true in America; it's true in Africa; it's true in Australia."

Such programmes are designed to bring broadband to the billions of

people around the globe who don't yet have internet access – and, in Musk's case, to Mars. But could they also help those in rural Britain who struggle to get decent connections?

"Satellite internet is just one of the technologies that could be used to bring broadband to the hardest-to-reach areas," suggested Nicholas Lansman, secretary general of the Internet Service Providers Association. "Industry



ABOVE Virgin has developed LauncherOne to deliver satellites into space

is determining the best solutions for the most rural areas and there's a £10 million government fund looking at technologies for rural broadband. Only time will tell whether Musk's proposals will be successful or not, but the internet industry has a track record of innovation for providing broadband access."

Broadband by balloon



sits at the bottom of the balloon, housing the necessary circuitry, antennae and solar-recharged batteries, to where it's dropped down to connect with the internet on the ground.

Loon was first piloted in New Zealand in June 2013, and has since seen successful trials in California and Brazil. It may seem rather unlikely to get beyond the trial phase, but a year after launch, Google X project director Mike Cassidy told *Wired*: "We've

Rumour has it that Google gave Project Loon its name because it's such a loony idea, but trials have suggested it may just work.

Project Loon sends a network of 15m-tall polyethylene balloons – more like weather balloons than those you'd find at a birthday party – up to the edge of space. There, they move around by rising or lowering in the wind, and provide an LTE signal to users below.

People can connect directly to the helium-filled balloons via their smartphone, tablet or other LTE device, with the signal routed via a 10kg box that

definitely crossed the point where there's a greater than 50% chance that this will happen."

His colleague Astro Teller, who heads the Google X division, was even more optimistic, claiming the balloons were offering ten times more bandwidth than expected – up to 22Mbps/sec to an antenna on the ground or 5Mbps/sec to a handset, speeds many would be happy with.

Saying telecoms companies are already showing interest, Teller predicted people in several countries would be connecting to balloons for internet service as early as summer 2015.



The smart sensors that will help machines learn to smell

Want your next fridge to know if your milk has gone off? Then machines need to learn how to smell – and Professor Krishna Persaud is working to make that happen. Here, he explains how sensors can tell caraway from spearmint

THE SIMPLEST WAY to determine whether milk has gone off is to give it a sniff. Unfortunately, this isn't yet something computers have learned to do, which means smart fridges aren't clever enough to tell us that we need to visit the dairy aisle at the supermarket.

However, this may one day be possible. Professor Krishna Persaud of the University of Manchester is one of the scientists currently looking for ways to teach machines to smell – and he's just published a breakthrough piece of research about smart sensors.

■ **Your research has found a way to recreate proteins normally found in the nose. So have you effectively replicated our sense of smell?**

They're not actually sensors or receptors; they're proteins that are carriers for smells. We've found a way to mass-produce these proteins using molecular genetics techniques.

We've also discovered how to modify these proteins in such a way that they can bind with compounds with which they wouldn't normally. So, we can actually target them. In this instance, we've chosen to modify a protein to detect molecules that are mirror images of themselves. We've used a compound called carvone, which has two forms: one smells like spearmint and the other smells like caraway. They're the same molecule chemically – they're images of each other.

We can actually make this protein detect these two compounds easily. The next step was to try to get a signal from these proteins, if we were to make a biosensor.

■ **How was this achieved?**

The proteins on their own don't do anything, they're only responsible for binding a molecule. We – in collaboration with an expert group at the University of Bari, led by Professor Luisa Torsi – have placed these proteins onto the gate of the transistor, so that when a molecule binds to that protein, we can receive a signal from the transistor.



■ **And that potentially gives computers the ability to smell?**

This signal is actually a change in the current that passes through the transistor. So that when a molecule binds, we can receive a simple signal to measure it. We can detect, say for example, 50 picomolar – that's 50 molecules in a billion molecules.

■ **How could these biosensors be used in the real world?**

One of the areas we had in mind was food-quality assurance. For example,

smart labels in packaging, where we have the ability to actually follow sensitive goods all the way from the manufacturing process, through transit, to the customer, to ensure that they're in good quality when they reach the customer.

The other significant application is environmental monitoring. The advantage that we have using this kind of device is that biosensors actually have very, very short lives: they're usually used once and then thrown away. In this case, we can actually use a sensor for a considerable amount of time, which means that we can follow events in real-time. So if you think of, say, monitoring pollution in the environment, then this allows you to deploy sensors and monitor target pollutants in real-time.

■ **Could smart sensors and labels be put to use in a smart fridge, to let you know that your milk has gone off?**

Yes, these sensors cut to the heart of such devices. I think it's going to be a few years yet, because... [this is] really a proof of concept to show that this approach actually works. ●

BELOW & LEFT Biosensors in smart fridges could warn us when food is off, and could also be used to monitor the environment



What is... G.fast?

BT is planning to roll out G.fast technology in 2016/17, promising 500Mbps/sec download speeds. Here's how it works and what it means for you



What would you do with a 500Mbps/sec broadband connection? You may soon get the chance to find out. BT is running a trial of a new technology called G.fast, which will let the ISP offer speeds of hundreds of megabits per second to most of the UK by 2020.

How does G.fast work? To answer that, you need to know two things. First, copper cable has the potential for high speeds, but they fall off over distances. Second, BT is rolling out most of its fibre as fibre-to-the-cabinet, rather than to the premises, with the last stretch of cable to the home or business on copper. The idea behind G.fast is to bring fibre closer to people's homes and businesses – it's part of a wider architecture known as fibre-to-the-distribution-point. Using it, a small number of premises will be connected to a fibre node by copper, usually within a few hundred metres at most. Over that distance, speeds over copper remain relatively fast, and then the data transmission hops onto superfast fibre.

A fibre node? Does this mean BT will be installing more cabinets on streets? No. One of the upsides of G.fast is that a node can be quite tiny – as small as a shoebox. This means it can be fixed to the side of a building or a telegraph pole to serve nearby homes without cluttering up streets or ripping up roads to lay cables. That's not only handy for us, it also means that rollout is cheaper for BT than alternative upgrades.

When will this speed into British homes? BT is moving quickly: the G.fast specification for equipment was approved in December 2014, and the company has said it will run a pair of G.fast trials this summer, in Huntingdon, Cambridgeshire, and Gosforth, Newcastle. Assuming those pilots go well, BT has said deployment will begin in 2016/17. At first, speed will be limited to a "few hundred" megabits per second; BT believes it can cover millions of homes and businesses across much of Britain by 2020. Following this, improvements in hardware should boost speeds to 500Mbps/sec within a decade. Lab tests have shown G.fast topping out at 1Gbit/sec downstream, and BT has suggested it might offer a premium service at that speed.

What about upstream speeds? In BT's tests carried out at Adastral Park labs, G.fast combined with 66m of copper – which BT says would cover 80% of connections – topped out at 700Mbps/sec for downloads and a whopping 200Mbps/sec for uploads.

What about rural areas that are already being left behind? G.fast relies on the presence of a fibre connection, so this could help those who are a few kilometres from a cabinet by bringing the fibre node closer to home. For those further afield, it likely won't be much help. Fortunately, there are other plans to reach them (see p124).

Crowdfund this!

Our pick of UK tech projects on Kickstarter and Indiegogo

OwnFone



Oh great, another phone – just what the world needs. Be fair: this isn't just another phone. The OwnFone is a 3D-printed handset that can be customised in any number of different ways depending on what it will be used for, or who it will be used by. There's no screen, texting or the internet: it's a tiny 2G device for, well, making calls.

Making calls – who does that with phones these days? The developers are pitching it as an emergency device for seniors; a first handset for children; even a long-lasting phone for festivals – although they've clearly never tried to make a call in the middle of a mosh pit. That said, the three-day battery life is appealing.

How can you customise it? In a number of ways. You can print images onto buttons instead of having a standard numerical keypad – handy for small children. You can even draw the images yourself or, better still, let the kids do it. There's a bio version made from natural materials including wood or stone; a glow-in-the-dark unit; one made from Lego; and a handset incorporating built-in reflectors to use as an emergency device when out running.

If none of those appeal, you can buy the parts for the OwnFone and 3D print your own shell at home. If, bizarrely, you don't have a 3D printer, simply print your own design on paper to use with a clear case. Yet another option is 3D buttons, including the ability to use Braille – the OwnFone founder claims his original BrailleFone was the first in the world.

Wait, this isn't new? The OwnFone first launched in 2012 here in the UK; this funding is so the phones can start shipping across the EU and the US.

What does it cost? The cheapest OwnFones are £66, and those made with specialist materials cost £80. A kit to 3D print your own handset costs £119 – no, we don't know why it's a higher price either. Delivery is expected by July.

Link: pcpro.link/24townfone



Geek Day Out: National Media Museum

Head to Bradford to find unique memorabilia from the worlds of photography, television and new media – and maybe play a video game or two



If you find yourself in Bradford with an odd desire to play Pong, you're in luck: the National Videogame Archive at the National Media Museum will happily cater to your needs.

The museum opened its doors in 1983, and is home to photography, cinematography and television collections. It subsequently added the New Media Gallery, and in 2008 opened the video-game archive too.

"The games lounge came about as video-game graphics are strongly linked to animation, a subject we cover in depth in our cinematography collection," said Michael Terwey, head

“The Life Online exhibition is a real trip down memory lane for anyone who's grown up in the digital age”

of collections and exhibitions. "It seemed like a perfect way to feature another aspect of animation, as well as providing lots of entertainment and nostalgia."

You can play Pong, Donkey Kong and Space Invaders, but those games are in addition to the unplayable and protected official National Collection – yes, there is one for video games – that the museum preserves "on behalf of the nation".

There's also the interactive Life Online exhibition, which Terwey describes as "a real trip down memory lane for anyone who's grown up in the digital age". Terwey said visitors can "discover the history of the still and moving image – how technology has developed over the past 200 years".

The National Media Museum (nationalmediamuseum.org.uk) is open every day from 10am to 6pm and entry is free.

ABOVE Have a game of Pong, Donkey Kong or Space Invaders in the Videogame Archive at the National Media Museum



LEFT The Life Online gallery traces the impact of the internet on our lives

Coming up Project Phire

Gorilla Glass is strong but still prone to scratches. Corning hopes that with Project Phire it will be able to add a final layer of protection with a scratch-resistant glass based on sapphire

Smartphones with scratched glass could go the way of physical keyboards and flip phones, if Corning has its way. Corning has long claimed that its own toughened glass, Gorilla Glass, survives better if dropped than glass made with synthetic sapphire – but the latter is far more scratch-resistant. This is one of the reasons behind Apple's plans to use sapphire glass for its Watch; the company has already switched to using sapphire for the iPhone 6's fingerprint scanner.

Apple's sapphire supplier, GT Advanced Technologies, filed for bankruptcy last year, giving Corning the opportunity to get ahead in this market. And the signs are that the company has succeeded. James Clappin, president of Corning Glass Technologies, told us that his firm has created a new version of Gorilla Glass, dubbed Project Phire, which offers the same level of toughness as Gorilla but has "scratch resistance that approaches sapphire".

Not only will this expand Corning's portfolio, with glass that can be used on smartwatches and camera lenses, it may also be used to front smartphones. Real sapphire is too expensive to use as a display cover for all but a few niche ruggedised or luxury handsets; Apple was reported to be considering it for the iPhone 6 and 6 Plus, but its supplier couldn't make enough.

While Corning has said that Project Phire glass will be made available to suppliers later this year, it's still unclear how much extra it will cost compared to Gorilla Glass – and whether Corning can create enough to satisfy the demands of smartphone makers.

Coding challenge

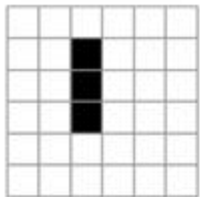
Reproduce a classic program devised in the 1970s

» The Game of Life

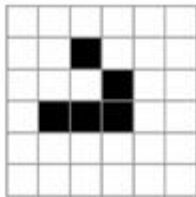
John Conway developed the Game of Life in the 1970s. It's a classic programming project that simulates a simple form of life inside a computer program. It's based on a two-dimensional grid in which each cell can be either occupied or empty – "alive" or "dead", as it were. The "game" plays out over multiple generations, as cells reproduce and die according to the state of their neighbours. The specific rules are:

- 1 **Any live cell with fewer than two live neighbouring cells dies in the next generation (due to isolation)**
- 2 **Any live cell with more than three neighbours dies (due to overcrowding)**
- 3 **Any live cell with two or three live neighbours lives on**
- 4 **Any empty cell with exactly three live neighbour cells is filled with a new living cell**

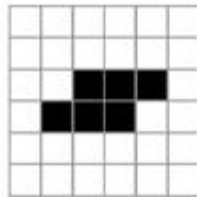
These simple rules produce some interesting and surprisingly complex behaviours. The following patterns of cells, for example, develop in very different ways over the generations:



"Blinker"



"Glider"



"Toad"

The Game of Life developed from the ideas of John von Neumann, who was trying to create a machine that could replicate itself. Self-replicating technology is a controversial topic, however: if a robot could build an exact replica of itself, then those robots could each build further replicas, and so on. The number of robots would grow exponentially and overwhelm us. In 2003, Prince Charles voiced concern about a "grey goo" doomsday scenario in which self-replicating nanotechnologies could end up covering the planet. Clearly, it's much safer to try out such ideas in software!

Even if you're familiar with the workings of the Game of Life, implementing it is still a rewarding exercise. The two-dimensional grid is where all the action takes place, so we'd start by setting up a data structure, such as an array, to store all of the cell values. To get things going, we'll also want to set up a "seed" state – initialising the cells, so that some are alive and the processes of death and reproduction can start.

So far, so good. But when it comes to producing the second generation you may encounter a problem. If you update the values of cells as you go, you'll be overwriting the original information – which you need in order to correctly calculate the new values of neighbouring cells.

One way to overcome this is to have two arrays of data, one that keeps the "last state" and a second that's generated from the rules as you apply them. Once you've constructed the next generation, you can copy the second array onto the first and begin the whole process again.

Another problem is that, ideally, the Game of Life universe should be unbounded: if your grid has edges, this will interfere with the natural growth of your cells. Clearly, this isn't possible



within the finite resources of your machine – so an alternative approach might be to "wrap around" the edges of the screen. You're probably familiar with this arrangement from early computer games, where a spaceship moves off one side of the screen to appear on the other.

Once we have a working implementation of the game, it's time to think about optimisation. At the moment, we're thinking of each of the cells as a single bit – but if we store an integer value instead, we could record the number of living neighbours within the cell itself. This would mean we'd have to do more work when a cell changed state – we'd need to update its neighbours,

as well as its own data – but we'd save a lot of work overall, since we could check just one number, rather than eight, to know whether a given cell was about to live or die.

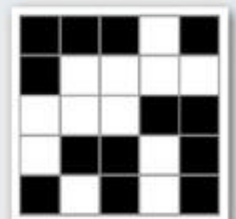
Finally, it's all

very well to have your model working in memory, but since the whole point is to observe how your cells develop, you'll want to output a graphical representation of each generation to the screen – and update it slowly enough that you can see what's happening! **DAVID HUNT**

“ Prince Charles voiced concern about self-replicating nanotechnologies covering the planet ”

Challenge

Create a working Game of Life implementation using a 101 x 101 wraparound grid, and use this graphic as the "seed" in the centre of the grid. After 10,000 generations, what will have been the grid's peak population of living cells?





Your TV may be listening in on you, says Jon Honeyball, but the real problem is far worse

Poor Samsung. In mid-February, its name was at the front and centre of news reports across TV, the internet and papers, with screaming headlines such as the BBC's "Not in front of the telly: Warning over 'listening' TV".

The news that smart TVs might be monitoring what you say should come as no surprise. After all, if a device offers the capability for voice recognition and voice control, what do you expect? I guess most people would assume that the technology for this was embedded within the TV itself. But voice recognition works best when it has huge datasets to work with, and that means comparing your words with those of other people, which means running a cloud service where all the data can be compared.

The real disaster, of course, is allowing the story to be handled in this way. And for that, the vendors are entirely to blame.

Far too many companies make assumptions on behalf of their customers, only to discover that customers don't share them. This could be a cultural thing – Google thought it was perfectly okay to walk around with a pair of glasses incorporating a camera, blithely ignoring the fact that the majority might object to a camera being present in a gym changing room.

Smart TVs don't only listen to voices; my Samsung TV can also recognise gestures. It does this by pointing a camera into the room, and looking for hand-waving and other movement. This tech is incredibly clever, but the reality is that there's a camera pointing into the room.

The fact that people are concerned about this should be of no surprise. The thought of malware finding its way onto a smart TV that allowed for remote activation of the camera is enough to bring most of us out in a cold sweat. Consider for a moment what would happen if this TV were in your eight-year-old's bedroom, and it was found to be streaming the camera content to a remote site on the other side of the world.

The problem isn't that technology has progressed to allow such things to work. The problem isn't even that the default mode of operation is to enable these things and not give adequate warning during setup of the potential consequences. Nor is it that some smart TV vendors have been shown to play fast and loose with the information gathered from your device.

No – the real problem is that we have no meaningful security firewall within the house, acting as our outer boundary. It can't be fitted to the ADSL or fibre router; we need a transparent switch-based solution that sits just inside the router, through which all traffic will flow – including all Wi-Fi.

This perimeter guard needs to be heavily orientated towards user accessibility; most firewalls are frankly quite pitiful in their execution, and their reporting can make a grown man weep. It should have clear and clean web-based reporting, ideally available through the smart TV screen. It should be heavily monitoring all traffic, both inbound and outbound, to ensure that nothing strange is going on. It should learn the traffic patterns, and work on the assumption that a change to established patterns is likely to be a problem. And then should block accordingly.

Even better, it should act as a VPN endpoint, allowing mobile devices to "call home" through a private VPN tunnel, to be subjected to the house rule set before then connecting to the outside world.

Relying on what comes built into the Sky router or your BT Broadband box is inadequate, since these devices allow all traffic outbound. My box would know that a smart TV was trying to send data to a cloud service, and would lock this down until specifically enabled, with the user clearly understanding the consequences.

The box could do email scrubbing, web-content filtering, antivirus and malware cleaning too. It would be the first of a new generation of home-orientated security devices that brought security to the home in a way that really worked.

After all, if we're going to fit Ethernet to our washing machines, we have to be sure that the home network is safe. Locking down each device isn't going to work because users will either not know or not bother. We can't tell visiting friends that they can't attach their devices to our home networks, but we can ensure that the network boundary is significantly safer than it is today.

We trust our homes to be secure – it's high time that we have the same level of trust in our home computer networks too. I wonder who will be brave enough to rise to the challenge?

“The problem is that we have no meaningful security firewall within the house, acting as our outer boundary”

■ As a contributing editor to *PC Pro* since issue 1, Jon Honeyball has one sage piece of security advice to share: if in doubt, unplug it. Email jon@jonhoneyball.com



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